CHAPTER 700 STORMWATER QUALITY

SECTION 701 INTRODUCTION

701.01 Section Description

This chapter provides policies, design criteria and information for water quality best management practices, or BMPs as required by the City's National Pollutant Discharge Elimination System (NPDES) permit. Many sections of this chapter overlap with Chapters 200 and 300. Other chapters are referenced where appropriate.

701.02 Definitions

BMP	Best management practices can refer to structural measures (wetlands, ponds, sand filters, etc.) or non-structural measures (restrictive zoning, reduced impervious areas, etc.). BMPs are designed for the benefit of water quality and quantity. For the purposes of this chapter, BMPs refer to structural water quality BMPs.
BMP owner	The owner of the BMP, typically the property owner. The BMP owner may also be the leasee of property in the case of long term leases of commercial or industrial zoned properties. The leasee is considered the BMP owner only if the lease specifically states that construction by the leasee must meet applicable local codes and regulations.
BOD	Biochemical oxygen demand
Contributing drainage area	Contributing drainage area refers to the total drainage area to a given point, including offsite drainage.
Effective drainage area	Effective drainage area refers to the drainage area from a specific site, excluding offsite drainage, where offsite drainage either does not exist or where offsite drainage bypasses the site through culverts or other means.
Impervious area	Impervious areas are areas where the land surface has been altered to decrease the amount of rainwater infiltration. Impervious surfaces include paved roads, concrete driveways and rooftops.
Offline structure	Offline structures are BMPs that treat only the water quality volume (WQv). Flows exceeding the WQv bypass the structure and re-enter the watercourse below the BMP.
Redevelopment	Redevelopment means any construction, alteration, or improvement where structures are removed and/or replaced. Where the disturbance caused by redevelopment activities disturbs less than 0.5 acres, no water quality BMP plan shall be required. Staff has the discretion to exempt redevelopment activities disturbing up to 5% more area.
Stormwater quality management	A system of vegetative, structural, and other measures that reduce or eliminate pollutants that might otherwise be carried by surface runoff.
Total P	Total phosphorus
Total N	Total nitrogen.
TSS	Total suspended solids.
Treatment train	A treatment train consists of more than one BMP in series treating stormwater runoff. Such configurations are necessary when BMPs individually cannot meet the 80%

	TSS reduction goal.
Watershed	Watershed refers to the total drainage area contributing runoff to a single point.

701.03
Purpose and Background

Urban stormwater runoff contains many types and forms of pollutants. When compared to stormwater runoff from pre-development conditions, higher concentrations and some contaminants that are not naturally present in surface runoff from undeveloped local lands are found. Runoff from undeveloped watersheds contains sediment particles, oxygen-demanding compounds, nutrients, metals, and other constituents. Once developed, constituent loads increase because surface runoff volumes increase and the sources of many of these pollutants also increase. Supplemental applications of compounds, such as fertilizers, also tend to increase the availability of some pollutants to stormwater runoff.

Runoff water quality in urban areas can be extremely detrimental to local habitat. Paved surfaces and standing water bodies for stormwater management control elevate the temperature of water entering streams. Chemicals in standing water and ponds are oxidized, resulting in depressed levels of dissolved oxygen. Increased runoff volumes and rates create scour and deposition damage to in-stream habitat. Activities in urbanized areas, such as vehicular traffic, deposit pollutants such as heavy metals and oil & grease on paved surfaces where they easily wash off into the streams. All roadway construction and improvement projects that disturb more than ½ acre must meet the requirements of this chapter.

Best management practices (BMPs), both structural and non-structural, can reduce the amount of pollutants in stormwater. This section of the manual establishes minimum standards for the design, maintenance, application, and construction of water quality BMPs. The information provided in this chapter establishes performance criteria for stormwater quality management and procedures to be followed when preparing a BMP plan for compliance.

BMPs noted in this chapter refer to post-construction BMPs, installed after construction has been completed and the site has been stabilized. Installing certain BMPs, such as bioretention areas and sand filters, prior to stabilization can cause failure of the measure due to clogging from sediment. However, with a strict construction sequence, detention ponds and other BMPs can be installed initially during construction and used as sediment control measures. In those instances, the construction sequence must require that the pond is cleaned out with pertinent elevations and storage and treatment capacities reestablished as noted in the approved stormwater management plan.

701.04
Stormwater Quality
Control Requirements

The City of Indianapolis and Marion County have adopted a policy that the control of stormwater runoff quality countywide will be based on the management of total suspended solids (TSS). This requirement is being adopted as the basis of the county's stormwater quality management program for all areas of the county except the city limits of Beech Grove, Lawrence, Southport and Speedway. It should also be noted that control of sediment is required for construction site runoff citywide. The target TSS removal rate is 80%.

In addition to TSS removal, BMPs must also be designed to treat the water quality volume (WQv) or the first flush of runoff. Based on estimates in relevant literature, including Watershed Protection Techniques[1] and the final report of the Nationwide Urban Runoff Program, BMPs designed to treat the first flush runoff in the Indianapolis area would treat the runoff of up to 75% of the storms annually because the total storm depth of those storms is less than one inch.

[1] A periodic publication of the Center for Watershed Protection, Silver Springs, Maryland.

Water Quality Volume (WQ_v)

The Water Quality Volume is the storage needed to capture and treat the runoff from the first one inch of rainfall. In numerical terms, it is equivalent to an inch of rainfall multiplied by the volumetric runoff coefficient (R_v) and the site area.

The following equation is used to calculate WQ_v (in acre-feet):

$$WQv = \frac{(P)\,(Rv)\,(A)}{12}$$

where:

WQ_v = water quality volume (acre-feet)
P = 1 inch of rainfall
R_v = 0.05 + 0.009(I) where I is the percent impervious cover
A = area in acres

All new development projects requiring stormwater management plans (as noted in Section 101.03 of this manual) shall be required to treat the WQ_v. Redevelopment projects will be required to obtain stormwater quality approval if the redevelopment activity disturbs more than ½ acre. Staff has the discretion to exempt redevelopment activities disturbing up to 5% more area.

702.00
Structural Best Management Practices

Table 702.00-1 identifies pre-approved structural BMPs that can be used in Indianapolis for water quality control. The BMPs noted in Table 702.00-01 are pre-approved BMPs if designed according to the criteria set forth in this chapter. Note that many of these measures can also be designed to meet the water quantity control requirements. Specific water quality design requirements are presented in the following sections.

Table 702.00-2 provides a summary of approved BMPs for different uses.

702.01
Innovative BMPs

Unapproved BMPs (BMPs not included in Table 702.00-1) must be professionally certified and approved through the New Product Committee. ASTM standard methods must be followed when verifying performance of new measures. New BMPs must meet the 80% TSS removal rate and must have a low to medium maintenance requirement to be considered by the City. Testing to establish the TSS removal rate must be conducted by an independent testing facility, not the BMP manufacturer.

702.02
Inspection and Maintenance

Each BMP on a site must have an operations and maintenance plan as specified in Section 102.06. The maintenance plan must be submitted with the stormwater management plan and approved by the City. The approved operations and maintenance plan must be provided to the BMP owner.

Annual inspections of permanent BMPs will be performed by the City. Prior to stormwater management plan approval, the developer or owner of a site must pay a predetermined fee to cover the City's costs for annual inspection for the first 3 years. The schedule of fees in Chapter 100 contains a set annual inspection cost. After the first 3 years, the City will inspect the facility and bill the owner.

Table. 702.00-1 Pre-Approved BMPs

BMP Type	Description	Quantity control	WQv and 80% TSS removal
Stormwater Ponds • Wet pond • Wet extended detention pond • Micropool extended detention pond • Multiple pond systems	Stormwater ponds are constructed stormwater retention basins with a permanent pool (or micropool) of water. Runoff from each rain event is captured and treated in the pool.	Yes	Yes
Stormwater Wetlands • Shallow wetland • Extended detention wetland • Pond / wetland systems • Pocket wetland	Stormwater wetlands are constructed, artificial wetland systems used for stormwater management. They consist of a combination of shallow marsh areas, open water and semi-wet areas above the permanent pool.	Yes	Yes
Bioretention Areas	Bioretention areas are shallow stormwater basins or landscaped areas that utilize engineered soils and vegetation to capture and treat stormwater runoff.	No	Yes
Sand Filters • Surface sand filter • Perimeter sand filter	Sand filters are multi-chamber structures designed to treat stormwater runoff through filtration, using a sand bed as its primary filter media.	No	Yes
Water Quality Swales • Dry swale	Water Quality swales are vegetated open channels that are designed and constructed to capture and treat stormwater runoff within dry cells.	No	Yes
Biofilters • Filter strip • Grass channel	While biofilters provide some filtering of stormwater runoff, by themselves they cannot meet the 80% TSS removal performance goal. *These measures can only be used as pre-treatment measures or as part of a treatment train.*	No	No
Catch Basin Inserts • Various designs	Catch basin inserts are small filtering devices installed in each catch basin to trap suspended solids and other pollutants. Catch basin inserts must conform to the requirements noted in Section 702.09.	No	Yes

Table 702.00-2 BMP Selection Criteria

Current Use	Planned Use	Approved BMPs
Open land	Commercial strip, light industrial, institutional (individual lots)	Biorention, wet pond, artificial wetland, sand filters, biofilter, water quality swale, catch basin insert
Open land	Commercial or industrial subdivision (regional stormwater plan)	Wet pond, wetland
Open land	Residential	Bioretention, wet pond, artificial wetland, biofilter, water quality swale
Commercial building or strip (medium imperviousness)	Commercial building or strip	Bioretention, Sand filter, catch basin insert, wet pond, wetland
Commercial building or strip (small lot, high imperviousness)	Commercial building or strip	Bioretention, Sand filter, catch basin insert
Transportation infrastructure	Increased / expanded transportation infrastructure	Water quality swales, wet ponds, artificial wetlands, catch basin inserts

Routine inspections are the responsibility of the BMP owner. Maintenance is also the responsibility of the owner. The approved maintenance plan and inspection forms provided at the ends of each BMP section should be used as guidance for performing maintenance activities. Completed inspection forms must be maintained by the BMP owner and produced upon request by the City. The City must be notified of any changes in BMP ownership, major repairs or BMP failure in writing within 30days. The letter should be addressed to :

Stormwater BMP Modifications
Department of Public Works
City-County Building
200 E. Washington, Suite 2460
Indianapolis, IN 46204

In the event that the City finds a BMP in need of maintenance or repair, the City will notify the BMP owner of the necessary maintenance or repairs and give the landowner a timeframe for completing the maintenance or repairs. If the maintenance or repairs are not completed within the designated timeframe, the City shall perform the repairs or maintenance and bill the landowner for the actual costs for the work.

Wet retention ponds can be designed to meet both water quality and water quantity requirements. If the retention pond is to be designed for only water quality purposes, then the pond shall be designed to capture the water quality volumes as noted in Section 701.04. If the stormwater pond is to be designed for water quantity also, refer to Chapter 300.

Example schematics of stormwater ponds and variations can be found in Figures 702.03-1 – 702.03-4.

Site and Design Considerations

The following design and site considerations must be followed when designing a stormwater pond:

1. Design the pond with a minimum length to width ratio of 3:1 (preferably expanding outward toward the outlet). Irregular shorelines for larger ponds also provide visual variety.

2. Maximize flow length between the inlet and outlet structure. Use baffles if short-circuiting cannot be prevented with inlet-outlet placement. Long flow paths and irregular shapes are recommended.

3. When designing the BMP for the contributing drainage area, assume that the entire upstream watershed is fully developed. When designing the BMP for the effective drainage area where offsite areas bypass the BMP, the design shall only consider the drainage from the site.

4. Provide a sediment forebay or other pretreatment upstream from the BMP inlet.
   - The forebay must be sized to contain 0.1 inches of runoff per impervious acre of contributing drainage. The forebay storage volume counts toward the total water quality storage requirements.
   - Exit velocities from the forebay must be non-erosive.
   - Direct maintenance access for appropriate equipment must be provided to the forebay.
   - The bottom of the forebay may be hardened (e.g., using concrete, paver blocks, etc.) to make sediment removal easier.
   - A fixed vertical sediment depth marker must be installed in the forebay to measure sediment deposition over time.
   - Sediment removal in forebay shall occur when 50% of the total capacity has been lost.

5. Side slopes shall be no greater than 3:1 if mowed.

6. Rip-rap protection must be provided (or other suitable erosion control means) for the outlet and all inlet structures into the pond.

7. The minimum drainage area (contributing or effective) for stormwater ponds is 25 acres. The minimum drainage area (contributing or effective) for a micro-pool extended detention facility is 10 acres. (Note: Chapter 300 allows dry detention ponds for drainage areas much smaller than 10 acres. However, little water quality benefit is provided from dry detention ponds.)

8. Anti-seep collars or filter diaphragms must be provided for the barrel of principal spillway.

9. If reinforced concrete pipe is used for the principal spillway, O-ring gaskets (ASTM C361) shall be used to create watertight joints.

10. Provide a one (1) foot minimum freeboard above the maximum anticipated flow depth through the emergency spillway.

11. Design and install an emergency drain (i.e. sluice gate or drawdown pipe) capable of draining within 24 hours.

12. Emergency spillway designed to pass 1.25 times the peak discharge and peak flow velocity from the 100-year storm event for the entire contributing drainage area (unless bypassed), assuming post-development conditions (see Section 302.08).

13. Provide trash racks, filters, hoods or other debris control.

14. Regional facilities must be constructed within a stormwater easement either platted or legally described and recorded as a perpetual stormwater easement a minimum of 20 feet horizontally outside of the design 100-year flood water elevation of the basin. Provide a 10' foot wide permanent access easement for all local ponds for long-term maintenance.

15. Provide a permanent benchmark within the permanent pool and sediment forebay for sediment removal.

16. The principal spillway/riser system must incorporate anti-floatation, anti-vortex, and trash-rack designs.

17. To prevent drawdown of the permanent pool, an impervious soil boundary may be needed.

18. Orifice-type outlets are not allowed below the permanent pool elevation of wet ponds and micropools.

19. Construction debris cannot be disposed of within the facility or used as fill in the embankment.

20. The BMP must be located within an easement. The easement must include access to the BMP for maintenance. A copy of the easement should be included in the digital copy of the BMP operations and maintenance manual.

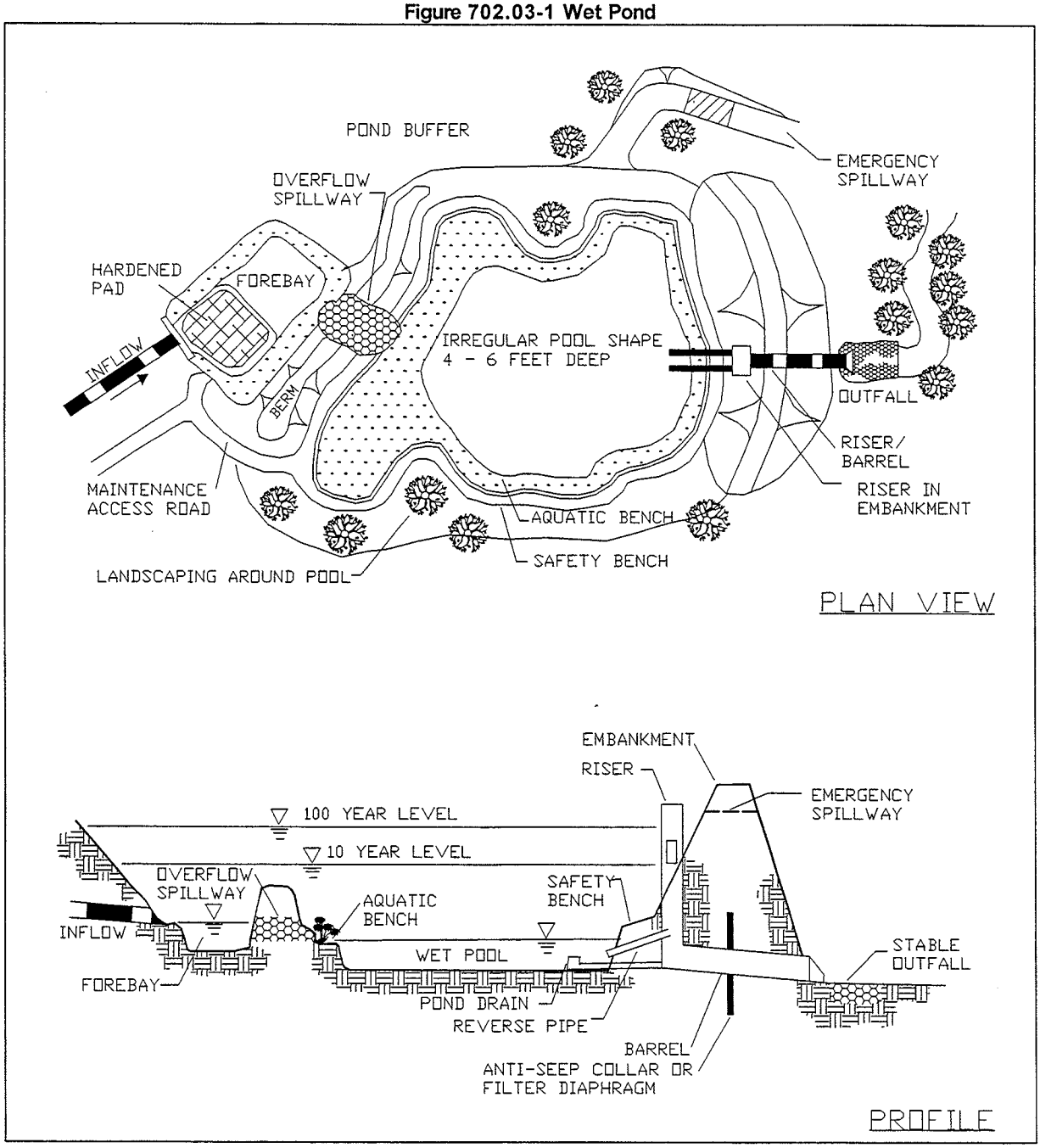
21. If the pond is used as a sediment control measure during active construction, the performance sureties will not be released until sediment has been cleaned out of the pond and elevations and grades have been reestablished as noted in the approved stormwater management plan for post-construction runoff control.

Performance Standards

Wet ponds and variations designed, constructed and maintained as noted above provide the following pollutant reductions:

Pollutant	Percent reduction
BOD	30%
TSS	85%
Total P	50%
Total N	30%
Metals	30%

Figure 702.03-1 Wet Pond



Variations

- **Wet extended detention ponds**: A wet extended detention pond is a wet pond where the water quality volume is split evenly between the permanent pool and the extended detention storage provided above the permanent pool. During storm events, water is detained above the permanent pool and released over 12 - 48 hours. This design has similar pollutant removal to a traditional wet pond, but consumes less space.

- **Micropool extended detention pond**: The micropool extended detention pond is a variation of the wet extended detention pond where only a small micropool is maintained at the outlet to the pond. The outlet is sized to detain the water quality volume for 24 hours. The micropool prevents resuspension of previously settled sediments.

- **Multiple pond systems**: Multiple pond systems consist of constructed facilities that provide water quality and quantity volume storage in two or more cells. The additional cells can create longer pollutant removal pathways and improved downstream protection.

Advantages

1. High pollutant removal
2. High community acceptance, if designed and maintained correctly
3. Opportunity for wildlife habitat
4. Multi-objective use for water quality and quantity control

Disadvantages

1. Potential for thermal impacts downstream
2. Dam height restrictions

Maintenance

Refer to the checklist provided in Figure 702.03-5 for operation, maintenance and inspection of stormwater ponds. The checklist is for the use of the BMP owner in performing routine inspections. The City will perform annual inspections of BMPs, using a similar checklist. The developer/owner is responsible for the cost of maintenance and annual inspections. See Section 103.04 for a schedule of fees. The BMP owner must maintain and update the BMP operations and maintenance plan. At a minimum, the operations and maintenance plan must include , but is not limited to:

1. Removal debris from inlet and outlet structures
2. Removal of invasive vegetation from all side slopes
3. Removal of sediment accumulation from forebay and permanent pool area when it is 50% full
4. Removal of woody vegetation from the embankment

Figure 702.03-2 Wet Extended Detention Pond

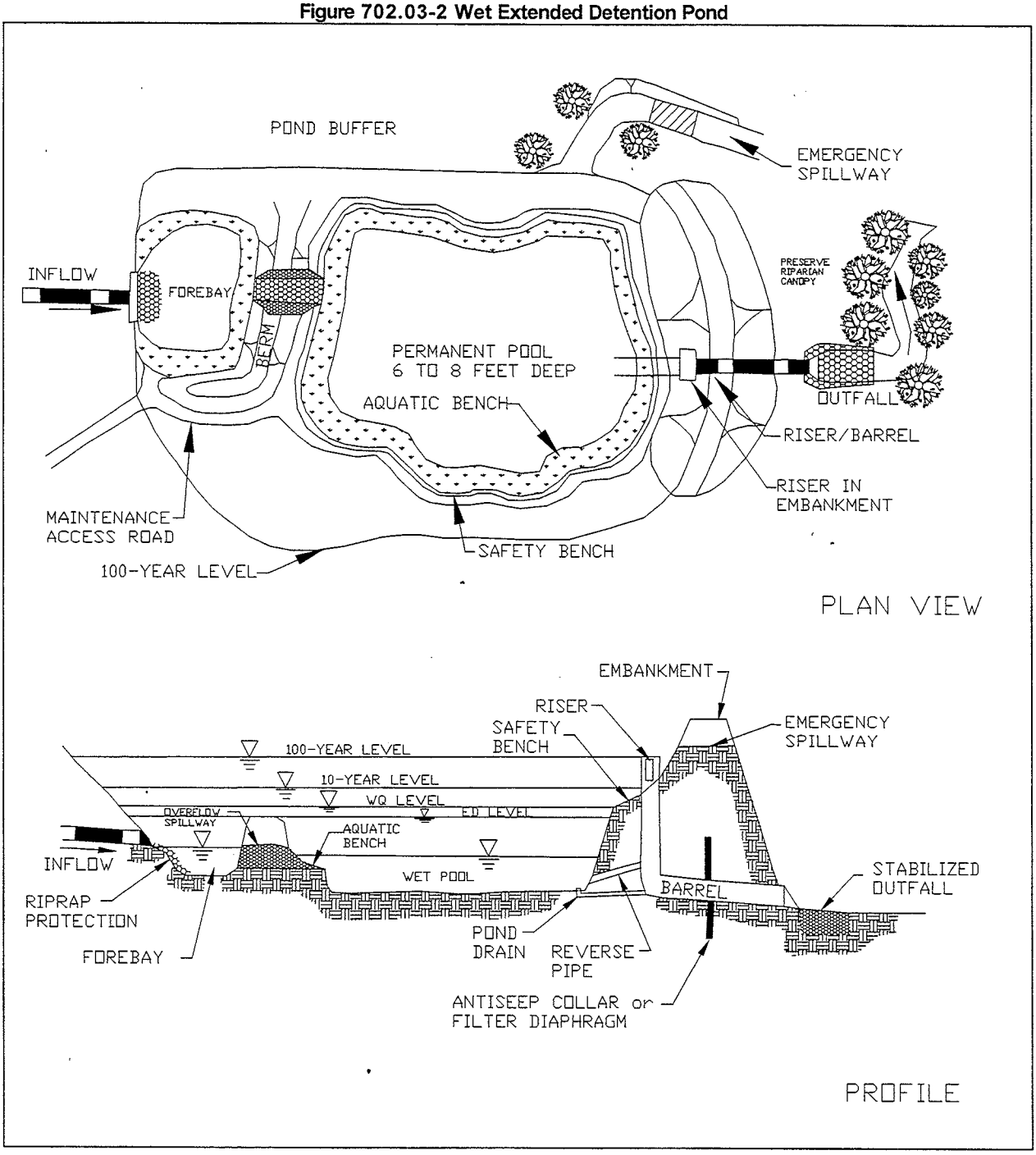


Figure 702.03-3 Micropool Extended Detention Pond

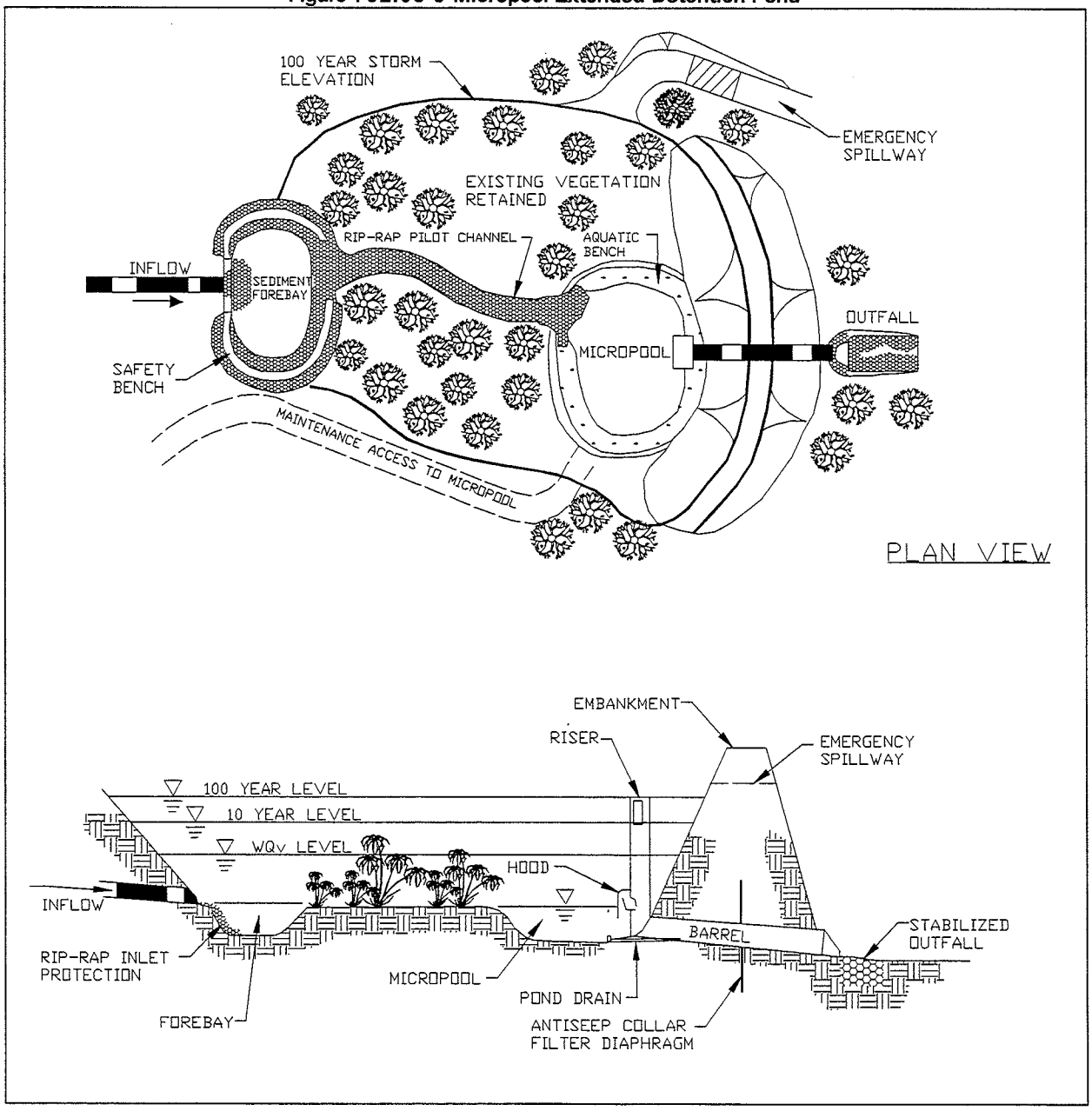
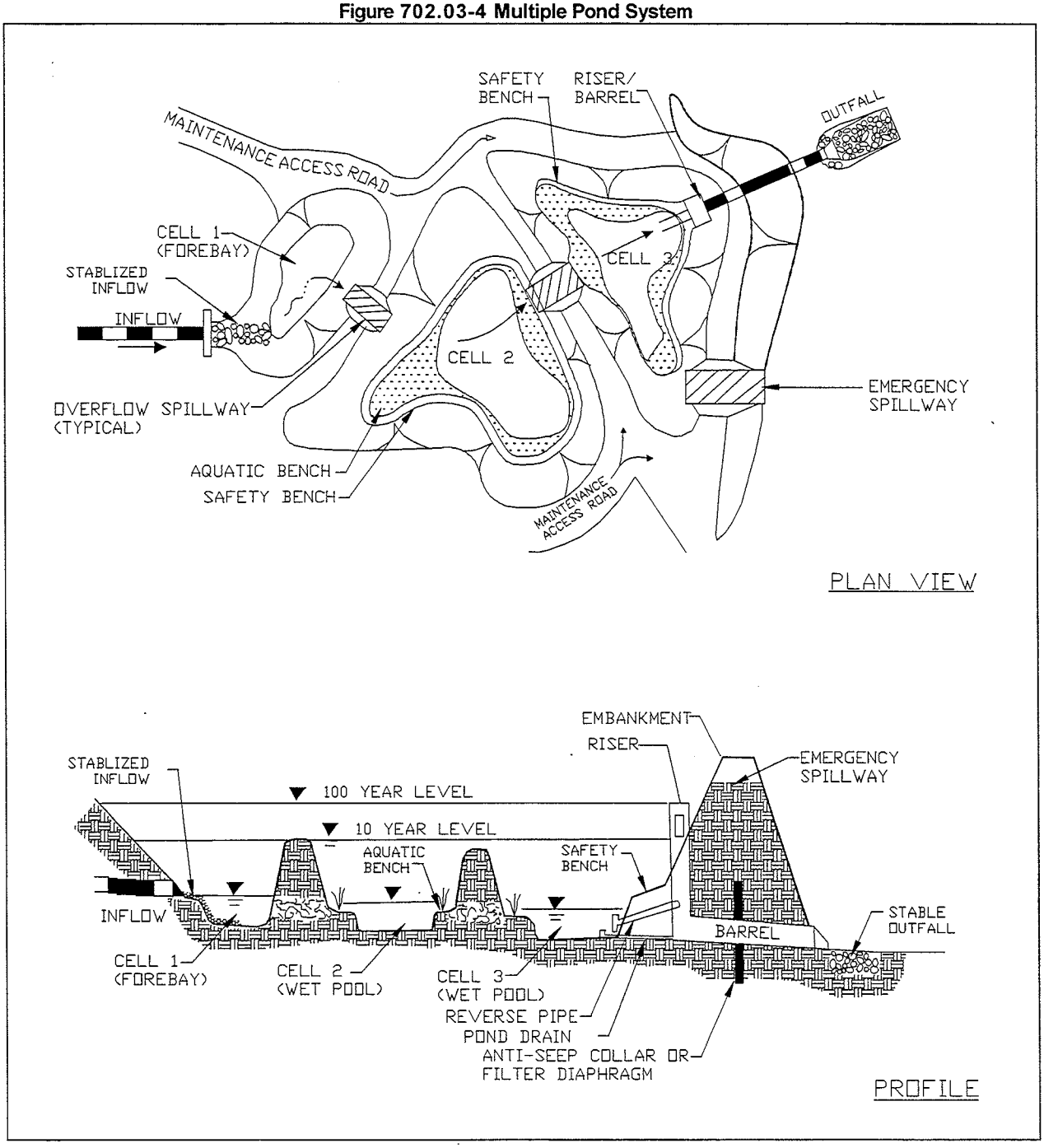


Figure 702.03-4 Multiple Pond System



Stormwater Pond Operation, Maintenance, and Management Inspection Checklist for BMP Owners

Project: _____ Owner Change since last inspection? Y N

Owner Name, Address, Phone _____

Number _____

Location: _____

Site Status: _____

Date: _____

Time: _____

Inspector: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Embankment and Emergency Spillway (Inspect annually and after major storms)		
1. Vegetation		
2. Erosion on embankment		
3. Animal burrows		
4. Cracking, bulging or sliding of dam		
A. Location:		
B. Describe		
5. Drains clear and functioning		
6. Leaks or seeps on embankment		
A. Location		
B. Describe		
7. Slope protection failure		
8. Emergency spillway clear of obstructions		
9. Other (describe)		

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Riser and Principal spillway (Inspect annually)		
Circle Type: Reinforced concrete, corrugated pipe, masonry		
1. Low flow orifice blocked		
2. Trash rack		
A. debris removal needed		
B. corrosion noted		
3. Excessive sediment buildup in riser		
4. Concrete/Masonry condition		
A. cracks or displacement		
B. spalling		
5. Metal pipe condition		
6. Control Valve operational		
7. Pond drain valve operational		
8. Outfall channels functioning		
9. Other (describe)		
Permanent Pool (Inspect monthly)		
1. Undesirable vegetative growth		
2. Floatable debris removal needed		
3. Visible pollution		
4. Shoreline problem		
5. Other (describe)		

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Sediment Forebays		
1. Sedimentation noted		
2. Sediment cleanout needed (over 50% full)		
Other (Inspect monthly)		
1. Erosion at outfalls into pond		
2. Headwalls and endwalls		
3. Encroachment into pond or easement area		
4. Complaints from residents		
5. Public hazards (describe)		

Additional Comments

Actions to be taken:	Timeframe:

Stormwater wetlands are artificial wetlands created for the purposes of stormwater pollutant removal and quantity control. It is the intent of the City and County to encourage regional stormwater wetlands and discourage artificial wetlands designed for individual sites. However, BMP plans will be reviewed on a case-by-case situation to determine feasibility.

Refer to figure 702.04-1 through 702.04-4 for schematics of stormwater wetlands. Figure 702.04-5 represents a cross-sectional view through the outlet system. Note: The waterfowl island in Figure 702.04-2 is an optional feature.

Site and Design Considerations

Prior to stormwater management plan approval, the following design and site considerations must be followed:

1. A water balance must be performed to demonstrate that a stormwater wetland could withstand a thirty-day drought at summer evaporation rates without completely drawing down. Also, inflow of water must be greater than that leaving the basin by infiltration or exfiltration. The following water balance equation should be used in calculations:

   $S = Qi + R + Inf - Qo - ET$

   Where:
   S = net change in storage
   Qi = stormwater runoff inflow
   R = contribution from rainfall
   Inf = net infiltration (infiltration – exfiltration)
   Qo = surface outflow
   ET = evapotranspiration

2. The wetland must be designed for an extended detention time of 48 hours for the WQ_v. The orifices used for extended detention will be vulnerable to blockage from plant material or other debris that will enter the basin with stormwater runoff. Therefore, some form of protection against blockage must be installed (such as some type of non-corrodible wire mesh).

3. The frequently flooded zone surrounding the wetland must be located within the permanent easement.

4. The surface area of the wetland must account for a minimum of 1 percent of the area of the watershed draining into it (1.5 percent for a shallow marsh design). The length to width ration must be at least 2:1.

5. The design must incorporate long flow paths through the wetland, as appropriate.

6. A forebay shall be established at the pond inflow points to capture larger sediments and be 4 to 6 feet deep. The depth of the forebay should contain approximately 10 percent of the total volume of the normal pool. Direct maintenance access to the forebay must be provided with access 25 feet wide minimum and 5:1 slope maximum. Permanent sediment depth markers must be provided.

7. If high water velocity is a potential problem, some type of energy dissipation device must be installed.

8. Site preparation: Soil types conducive to wetland vegetation should be used during construction. A list of hydric soils, developed by the NRCS, can be found in Appendix B7. The wetland must be designed to allow slow percolation of the runoff through the substrate (add a layer of clay for porous substrates). Ensure that the substrate, once flooded, is soft enough to permit relatively easy insertion of the plants.

9. Planting: The designer must maximize use of existing- and post-grading pondscaping design to create both horizontal and vertical diversity and habitat. A minimum of 2 aggressive wetland species of vegetation shall be established in quantity on the wetland. Three additional wetland species of vegetation shall be planted on the wetland, although in far less numbers than the two primary species. 30 to 50 percent of the shallow (12 inches or less) area of the basin shall be planted with wetland vegetation. The optimal depth requirements for several common species of emergent wetland plants are often six inches of water or less. Approximately 50 individuals of each secondary species must be planted per acre; set out in 10 clumps of approximately 5 individuals and planted within 6 feet of the edge of the pond in the shallow area leading up to the ponds edge; spaced as far apart as possible, but no need to segregate species to different areas of the wetland. Wetland mulch, if used, shall be spread over the high marsh area and adjacent wet zones (-6 to +6 inches of depth) to depths of 3 to 6 inches. A minimum 25 foot buffer, for all but pocket wetlands, must be established and planted with riparian and upland vegetation (50 foot buffer if wildlife habitat value required in design). In addition, the wetland must be located within a 40-foot wide easement. A list of wetland species indigenous to and commercially available in Indiana can be found in Appendix C7.

10. Surrounding slopes must be stabilized by planting to aid in trapping pollutants and preventing them from entering the wetland.

11. Maintain the wetland to prevent loss of area of ponded water available for emergent vegetation due to sedimentation and/or accumulation of plant material.

12. Obtain local assistance for specifications on plants to be used, planting schedule, soil requirements, mulch requirements, etc.

13. Construction debris cannot be disposed of in the facility or used as fill in the embankment.

14. If the wetland area or sediment forebay is used as a sediment control measure during active construction, the performance sureties will not be released until sediment has been cleaned out of the wetland or forebay and elevations and grades have been reestablished as noted in the approved stormwater management plan for post-construction runoff control.

15. Stormwater wetlands must be designed with the recommended proportion of depths noted in Table 702.04-01. The four basic depths and descriptions are:

    - *Deepwater:* 1.5 – 6 feet below normal pool elevation. Includes the outlet micropool and deep water channels through the wetland. This zone supports little emergent wetland vegetation but may support floating or submerged vegetation.
    - *Low marsh:* 6-18 inches below normal pool elevation or water surface elevation. This zone is suitable for the growth of several emergent wetland species.
    - *High marsh:* 6 inches or less below normal pool elevation. This zone will support a greater density and diversity of wetland vegetation than the low marsh. The high marsh area should have a greater surface area to volume ration than the low marsh area.
    - *Semi-wet zone:* Areas above normal pool elevation inundated by larger storm events. This area supports vegetation that can survive periodic flooding.

Table 702.04-1 Minimum Required Design Configuration for Stormwater Wetlands

Design Criteria	Shallow Wetland	Pond/Wetland	Pocket Wetland
Length to width ratio (min)	2:1	2:1	2:1
Allocation of WQv (pool/marsh) in %	25/75	70/30 (includes pond volume)	25/70
Allocation of surface area (deepwater/low marsh/high marsh/semi-wet) in %	20/35/40/5	45/25/25/5 (includes pond surface area)	10/45/40/5
Forebay	Required	Required	Optional
Micropool	Required	Required	Required
Outlet configuration	Reverse-slope pipe or hooded broad crest weir	Reverse-slope pipe or hooded broad crest weir	Hooded broad crest weir

Modified from Massachusetts DEP, 1997; Schueler, 1992

Performance Standards

Artificial wetlands designed, constructed and maintained as noted above provide the following pollutant reductions:

Pollutant	Percent Reduction
BOD	55%
TSS	95%
Total P	55%
Total N	45%
Metals	80%

Operation and Maintenance Recommendations

Each BMP must have an operations and maintenance plan submitted to the City for approval and maintained and updated by the BMP owner. Refer to Figure 702.04-6 for a checklist for routine operation, inspection and maintenance requirements for the BMP owner. The City will perform annual inspections, with a similar checklist. The BMP owner is responsible for the cost of maintenance and annual inspections. See Section 103.04 for the schedule of costs.

1. A stormwater management easement and maintenance agreement is required for each facility. The maintenance covenant must require the owner of the wetland to annually clean the facility and outlet structure. The maintenance agreement must provide for ongoing inspection and maintenance, with more intense activity for the first three years after construction. The easement must include the BMP, all outlet structures and access to the BMP. A copy of the easement should be included in the digital copy of the BMP operations and maintenance manual.

2. The wetland must be maintained to prevent loss of area of ponded water available for emergent vegetation due to sedimentation and/or accumulation of plant material.

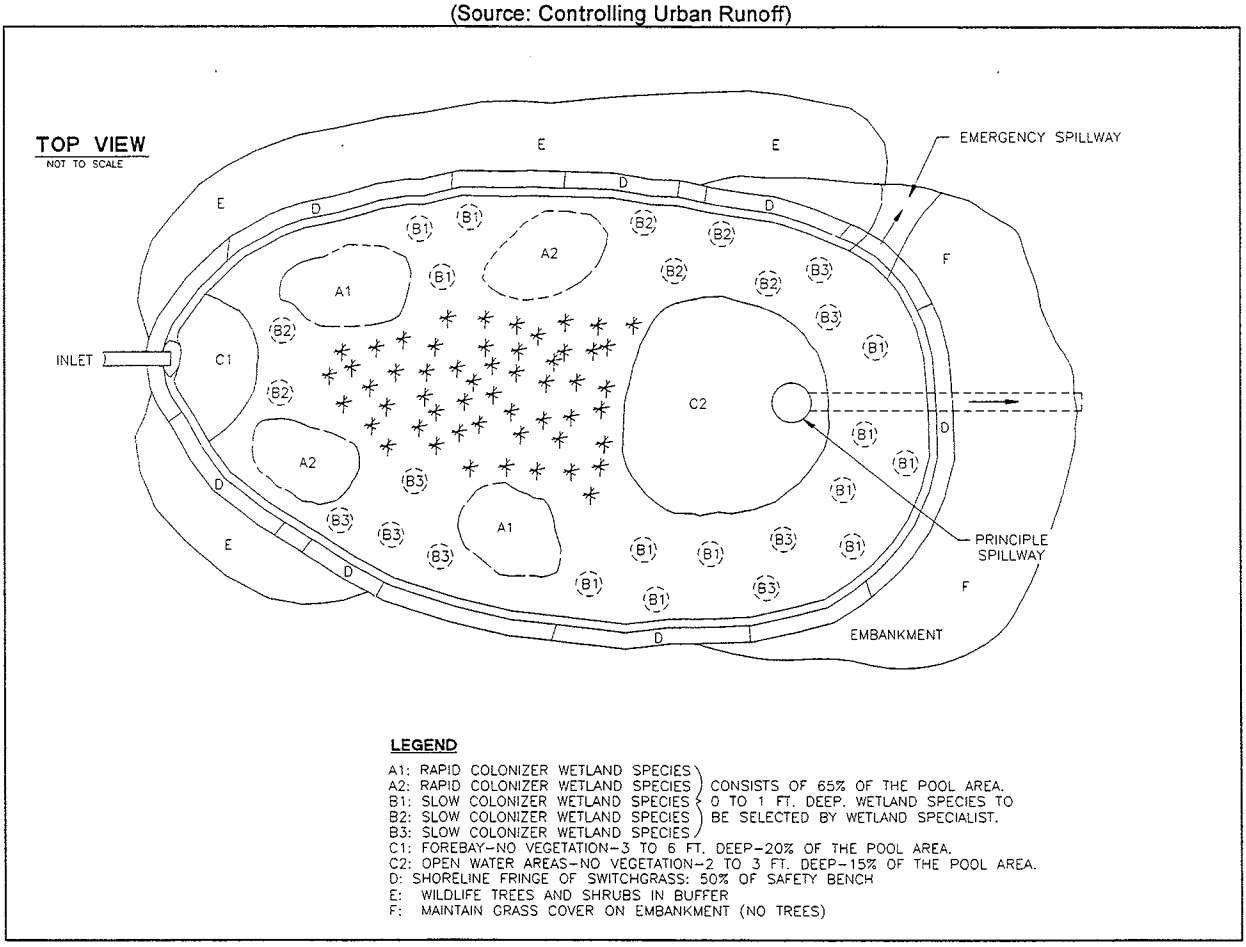
3. Sediment forebays must be cleaned when 50% full. Pocket wetlands without forebays must be cleaned after a six-inch accumulation of sediment.

4. The ponded water area may be maintained by raising the elevation of the water level in the permanent pond, by raising the height of the orifice in the outlet structure, or by removing accumulated solids by excavation.

5. Water levels may need to be supplemented or drained periodically until vegetation is fully established.

6. It may be desirable to remove contaminated sediment bottoms or to harvest above ground biomass and remove it from the site to permanently remove pollutants from the wetland.

Figure 702.04-1 Stormwater Wetlands
(Source: Controlling Urban Runoff)



LEGEND

A1: RAPID COLONIZER WETLAND SPECIES
A2: RAPID COLONIZER WETLAND SPECIES
B1: SLOW COLONIZER WETLAND SPECIES
B2: SLOW COLONIZER WETLAND SPECIES
B3: SLOW COLONIZER WETLAND SPECIES
CONSISTS OF 65% OF THE POOL AREA. 0 TO 1 FT. DEEP. WETLAND SPECIES TO BE SELECTED BY WETLAND SPECIALIST.

C1: FOREBAY–NO VEGETATION–3 TO 6 FT. DEEP–20% OF THE POOL AREA.
C2: OPEN WATER AREAS–NO VEGETATION–2 TO 3 FT. DEEP–15% OF THE POOL AREA.
D: SHORELINE FRINGE OF SWITCHGRASS: 50% OF SAFETY BENCH
E: WILDLIFE TREES AND SHRUBS IN BUFFER
F: MAINTAIN GRASS COVER ON EMBANKMENT (NO TREES)

Figure 702.04-2 Shallow Wetland

Courtesy of the Center for Watershed Protection

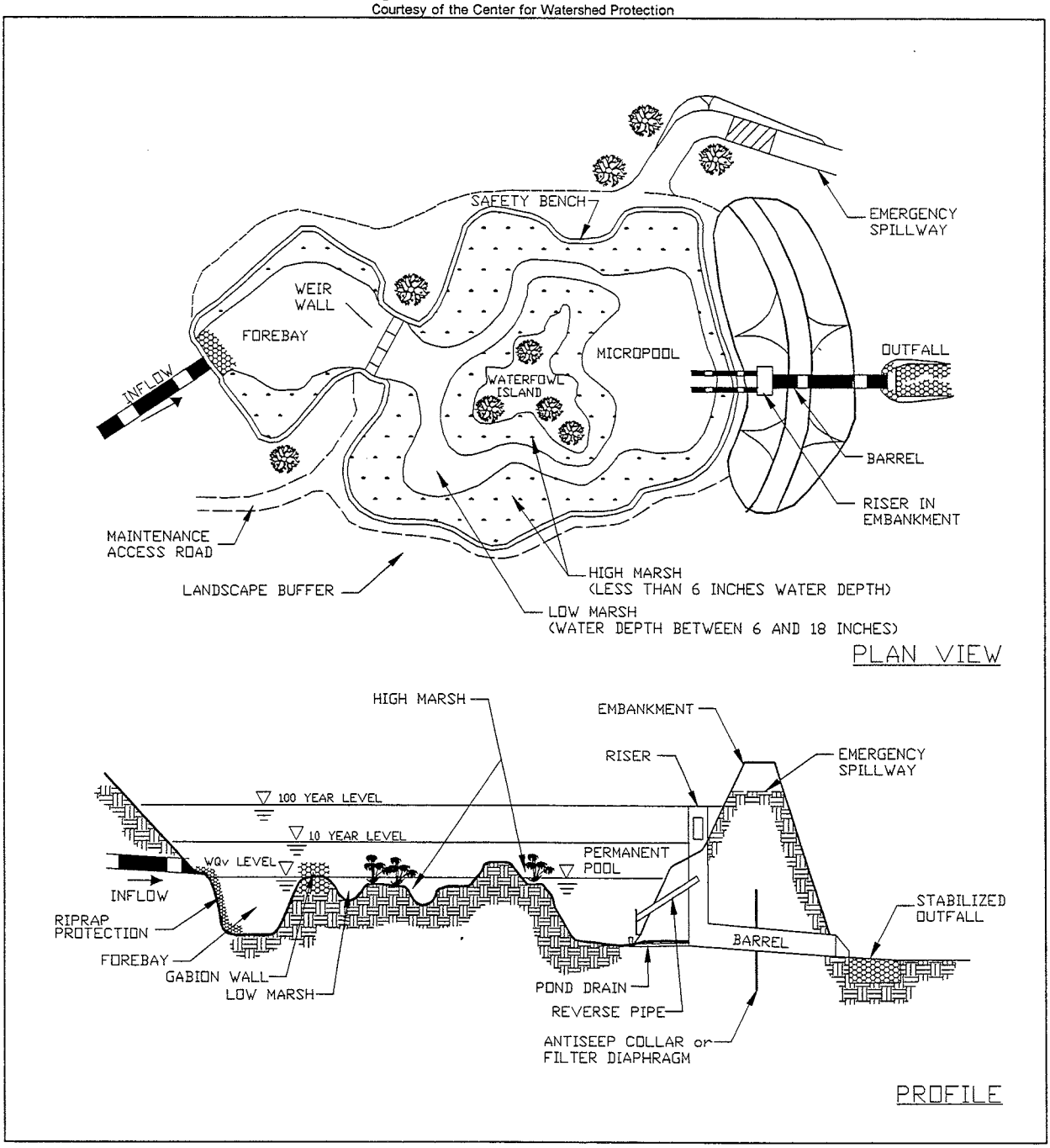


Figure 702.04-3 Schematic for a Pond/Wetland System

Courtesy of the Center for Watershed Protection

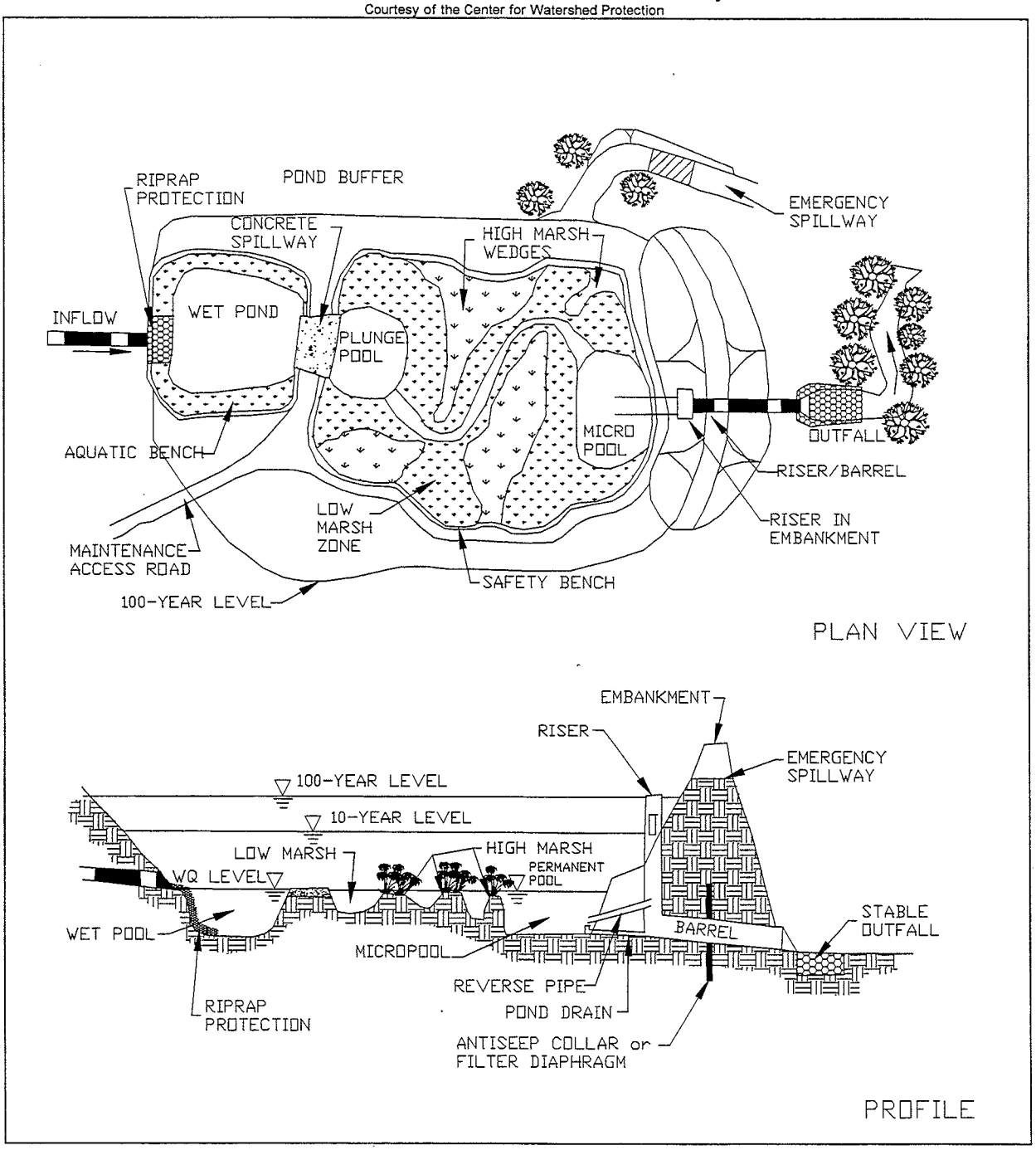


Figure 702.04-4 Schematic of a Pocket Wetland
Courtesy of the Center for Watershed Protection

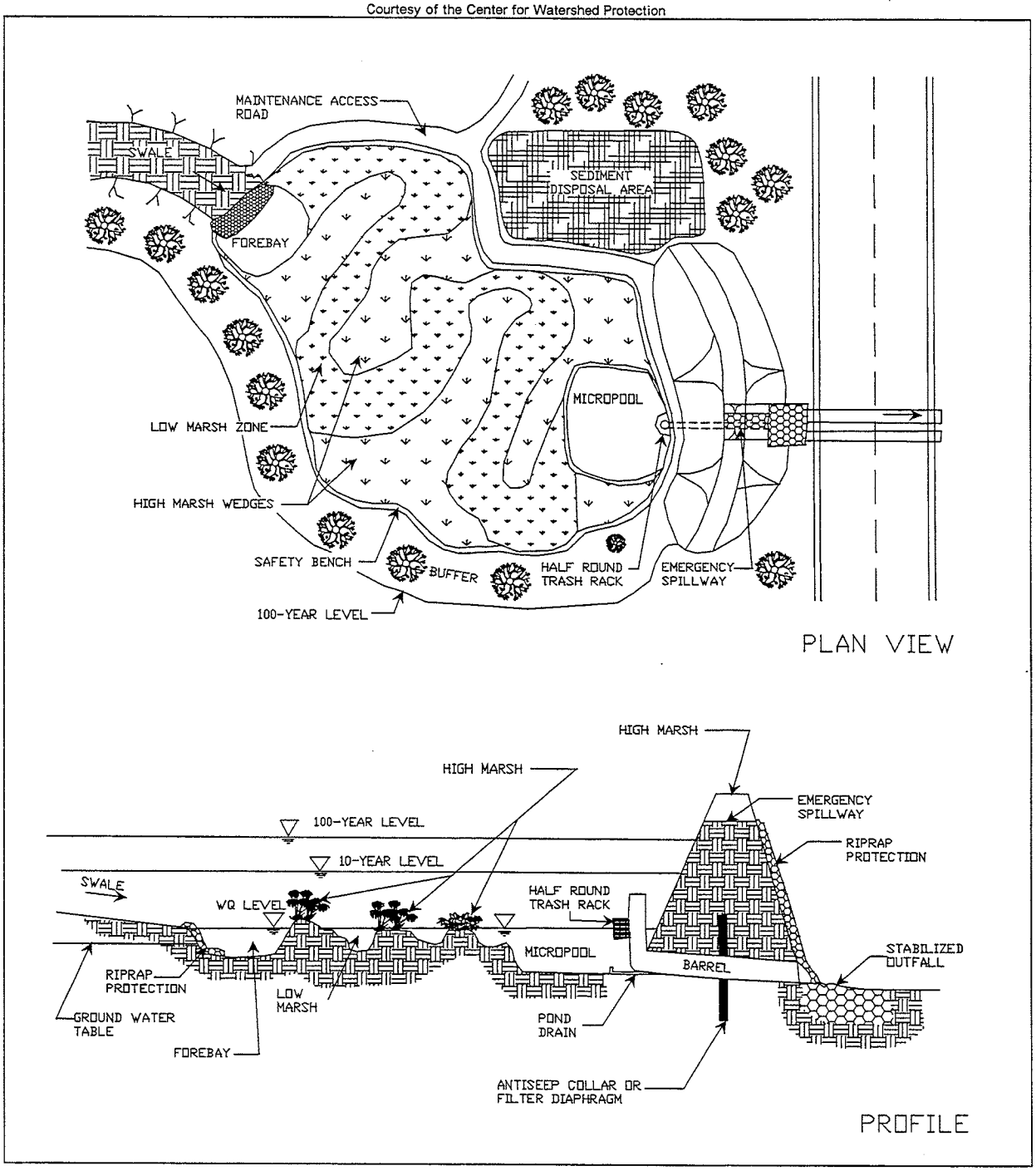
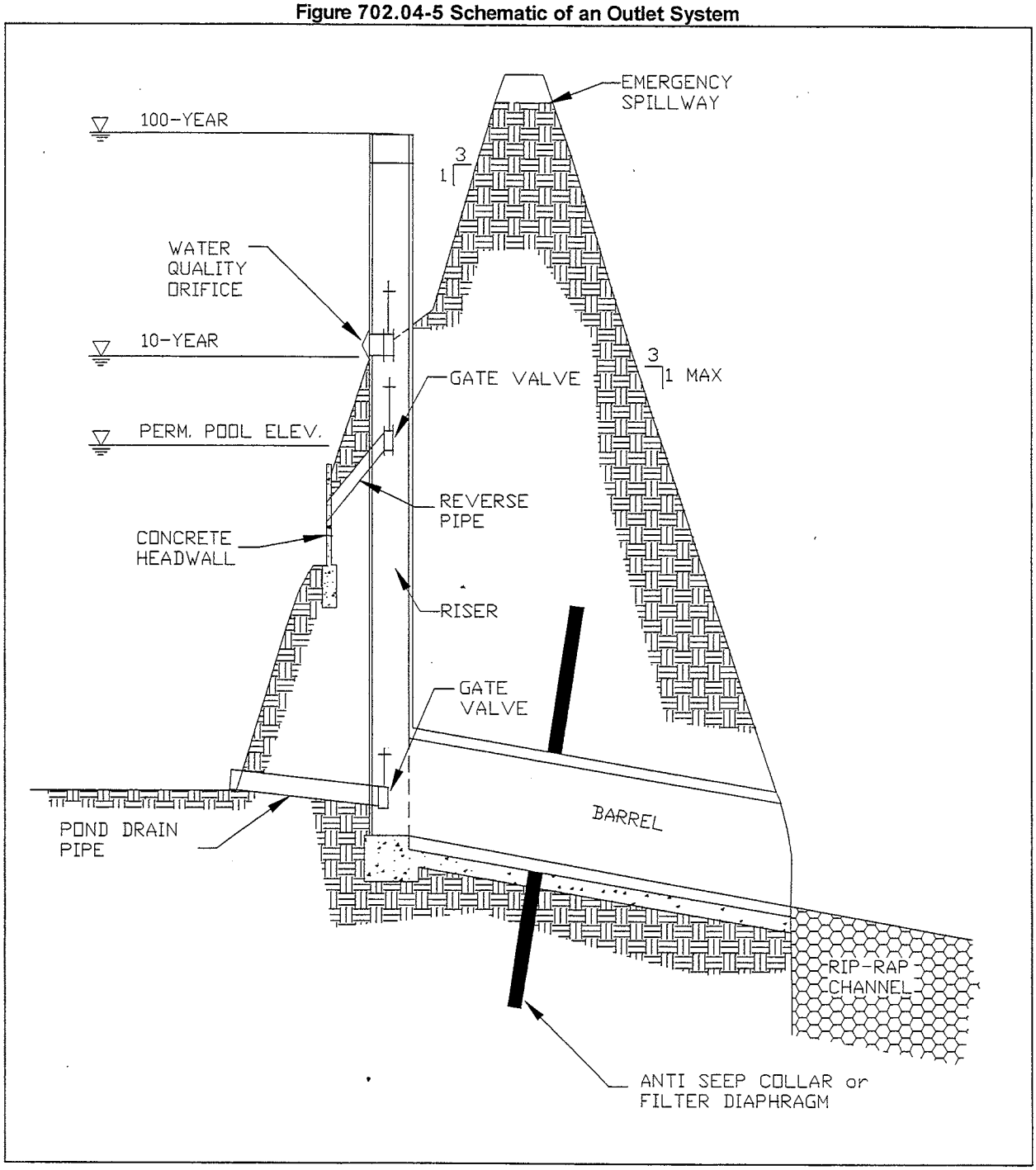


Figure 702.04-5 Schematic of an Outlet System



Constructed Wetlands Operation, Maintenance, and Management Inspection Checklist for BMP Owners

Site Name: _____ Owner changed since last inspection? Y N

Owner name, address, phone number: _____

Location: _____

Date: _____

Time: _____

Inspector Name: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Embankment and Emergency Spillway (Inspect annually and after major storms)		
1. Vegetation		
2. Erosion on embankment		
3. Animal burrows		
4. Cracking, bulging or sliding of dam		
A. Location:		
B. Describe		
5. Drains clear and functioning		
6. Leaks or seeps on embankment		
A. Location		
B. Describe		
7. Slope protection failure		
8. Emergency spillway clear of obstructions		
9. Other (describe)		

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Riser and Principal spillway (Inspect annually)		
Circle Type: Reinforced concrete, corrugated pipe, masonry		
1. Low flow orifice blocked		
2. Trash rack		
A. debris removal needed		
B. Corrosion noted		
3. Excessive sediment buildup in riser		
4. Concrete/Masonry condition		
A. cracks or displacement		
B. spalling		
5. Metal pipe condition		
6. Control Valve operational		
7. Pond drain valve operational		
8. Outfall channels functioning		
9. Other (describe)		
Permanent Pool (Inspect monthly)		
1. Undesirable vegetative growth		
2. Floatable debris removal needed		
3. Visible pollution		
4. Shoreline problem		
5. Other (describe)		
Sediment Forebays		
1. Sedimentation noted		

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
2. Sediment cleanout needed (over 50% full)		
Other (Inspect monthly)		
1. Erosion at outfalls		
2. Headwalls and endwalls		
3. Encroachment into easement area		
4. Complaints from residents		
5. Public hazards (describe)		
Constructed Wetland Area (Inspect annually)		
1. Vegetation healthy and growing		
2. Evidence of invasive species		
3. Excessive sediment in wetland area (clean out when 50% full or when vegetation damage noted)		

Additional Comments

Actions to be taken:	Timeframe:

Bioretention areas, or rain gardens, are structural stormwater controls that capture and temporarily store the WQ_v using soils and vegetation in landscaped areas to remove pollutants from stormwater runoff. Bioretention areas are engineered facilities in which runoff is conveyed as sheet flow to the "treatment area," consisting of a grass buffer strip, ponding area, organic or mulch layer, planting soil, and vegetation. An optional sand bed can be included in the design to provide aeration and drainage of the planting soil. The filtered runoff is typically collected and returned to the conveyance system, though it can be exfiltrated into the surrounding soil in areas with porous soils though exfiltration may not be permitted in Wellfield Zoning Districts.

There are numerous design applications, both on- and off-line, for bioretention areas. These include use on single family residential lots (rain gardens), as off-line facilities adjacent to parking lots, along highways and road drainage swales, within larger landscaped pervious areas, and as landscaped islands in impervious or high-density environments. However, the structures are not suitable as regional stormwater quality (or quantity) BMPs.

Bioretention facilities can provide a limited amount of water quantity control, with the storage provided by the facility included in the design of any downstream detention structures.

Bioretention areas are designed for intermittent flow and to drain and aerate between rainfall events. Sites with continuous flow from groundwater, sump pumps or other areas must be avoided.

Figure 702.05-1 illustrates a bioretention area. Bioretention areas consist of:

1. Grass filter strip between the contributing drainage area and the ponding area;
2. Ponding areas containing vegetation with a planting soil bed,
3. Organic/mulch layer, and
4. Gravel and perforated pipe underdrain system to collect runoff that has filtered through the soil layers (bioretention areas can optionally be designed to infiltrate into the soil).

Optional design components include:

1. Sand filter layer to spread flow, filter runoff and aid in aeration and drainage of the planting soil;
2. Stone diaphragm at the beginning of the grass filter strip to reduce velocities and spread flow into the grass filter;
3. Inflow diversion or an overflow structure.

Site and Design Considerations

The following design and site considerations must be incorporated into the BMP plan including bioretention areas:

1. The drainage area (contributing or effective) must be 5 acres or less, though 0.5 to 2 acres is preferred.
2. The minimum size for facility is 200 ft^2, with a length to width ratio of 2:1. Slope of the site can be no more than 6%.
3. Planting soil filter bed is sized using a Darcy's Law equation with a filter bed drain time of 48 hours and a coefficient of permeability (k) of 0.5 ft/day. The

planting soil bed must be at least 4 feet deep. Planting soils must be sandy loam, loamy sand or loam texture with a clay content rating from 10 to 25 percent. The soil must have an infiltration rate of at least 0.5 inches per hour and a pH between 5.5 and 6.5. In addition, the planting soil should have a 1.5 to 3 percent organic content and a maximum 500-ppm concentration of soluble salts.

4. The maximum ponding depth in bioretention areas is 6 inches.

5. Filter strip design for pre-treatment must follow the requirements outlined in Section 702.08.

6. The mulch layer must consist of 2-4 inches of commercially available fine shredded hardwood mulch or shredded hardwood chips.

7. The sand bed must be 12-18 inches thick. Sand must be clean and have less than15% silt or clay content.

8. Pea gravel for the diaphragm and curtain, where used, must be ASTM D 448 size No. 6 (1/8 " to 1/4").

9. The underdrain collection system must be equipped with a 6 inch perforated PVC pipe in an 8-inch gravel layer. The pipe must have 3/8-inch perforations, spaced on 6-inch centers with a minimum of 4 holes per row. The pipe is spaced at a maximum of 10 feet on center, and a minimum grade of 0.5% must be maintained. A permeable filter fabric is placed between the gravel layer and the planting soil bed.

10. The required elevation difference needed from the inflow to the outflow is 5 feet.

11. The depth from the bottom of the bioretention facility to the seasonally high water table must be a minimum of 2 feet.

12. Runoff captured by facility must be sheet flow to prevent erosion of the organic or mulch layer. Velocities entering the mulch layer must be between 1-2 fps.

13. Continuous flow from groundwater, sump pumps or other areas to the bioretention area is prohibited.

14. An overflow structure and a non-erosive overflow channel must be provided to safely pass the flow from the bioretention area that exceeds the storage capacity to a stabilized downstream area. The high flow structure within the bioretention area can consist of a yard drain catchbasin, with the throat of the catchbasin inlet typically 6 inches above the elevation of the shallow ponding area.

15. All components of the BMP must be located within an easement. Access to the BMP must be located within the BMP, if needed.

16. If the bioretention area is used as a sediment control measure during active construction, the performance sureties will not be released until sediment has been cleaned out of the bioretention area and elevations and grades have been reestablished as noted in the approved stormwater management plan for post-construction runoff control.

Performance Standards

Bioretention areas designed, constructed and maintained as noted in this manual provide the following pollutant reductions:

Pollutant	Percent Reduction
TSS	81%
Total P	29 %
Total N	49 %
Metals	61 %

Advantages

1. Applicable to small drainage areas
2. Often located in landscape islands
3. High pollutant removal
4. High community acceptance, if designed and maintained correctly

Disadvantages

1. Requires extensive landscaping
2. Not recommended for areas with steep slopes

Maintenance

A BMP operations and maintenance plan is required for bioretention facilities. The plan must be approved by the City and maintained and updated by the BMP owner. Refer to Figure 702.05-2 for a checklist for BMP owners for the routine operation, maintenance and inspection of bioretention areas. The City will perform annual BMP inspections, using a similar checklist. The BMP owner is responsible for maintenance costs and inspection fees. See Section 103.04 for the schedule of fees.

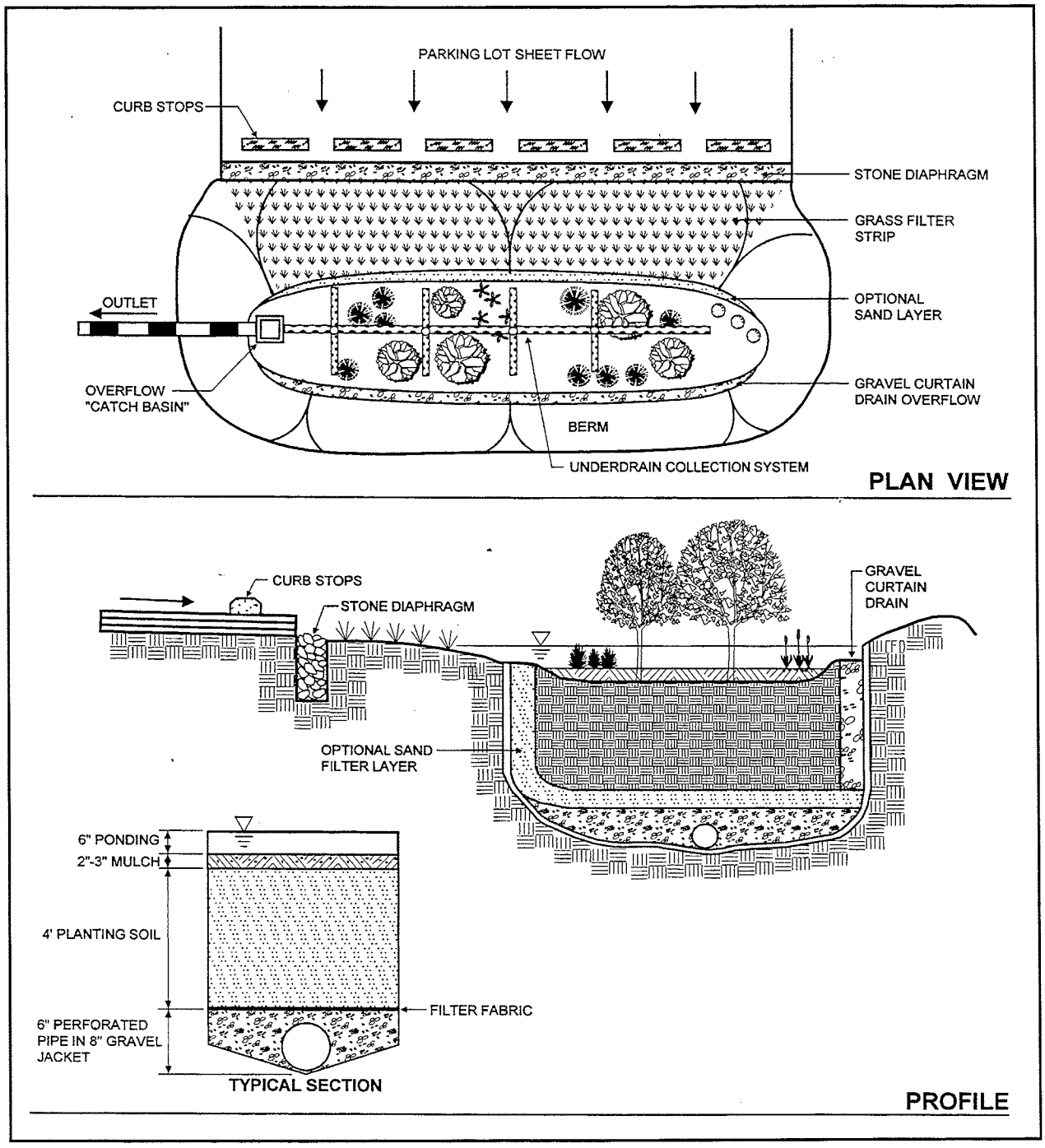
1. Inspect and repair/replace treatment components.

Landscaping

Landscaping is critical to the performance and function of the bioretention area. A dense and vigorous groundcover must be established over the contributing pervious drainage area before runoff can be diverted into the facility.

1. The bioretention area should be vegetated like a terrestrial forest ecosystem, with a mature tree canopy, subcanopy of understory trees, scrub layer and herbaceous ground cover. Three species of each tree and shrub type should be planted.
2. The tree-to-shrub ration should be 2:1 to 3:1. On average, trees should be spaced 8 feet apart. Plants should be placed at regular intervals to replicate a natural forest. Woody vegetation should not be planted at inflow locations.
3. After the trees and shrubs are established, the ground cover and mulch should be established.
4. Use native plants, selected based upon hardiness and hydric tolerance.

Figure 702.05-1 Bioretention Area



Bioretention Operation, Maintenance, and Management Inspection Checklist for BMP Owners

Site Name: _____ Owner changed since last inspection? Y N

Owner name, address and phone number: _____

Location: _____

Date: _____

Time: _____

Inspector Name: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Debris Cleanout (Inspect monthly)		
1. Bioretention area and contributing areas clean of debris		
2. Litter (branches, etc.) has been removed		
Vegetation (Inspect monthly)		
1. Plant height note less than design ponding depth		
2. Plant composition according to approved plan		
3. Grass height not more than 6 inches		
4. No evidence of erosion		

Additional Comments and Actions to be Taken	Timeframe:

702.06
Sand Filters

Sand filters are structural stormwater controls that temporarily store stormwater and pass it through a filter bed of sand. Most sand filter systems contain two chambers. The first chamber is a sedimentation chamber that removes floatables and heavy sediments. The second chamber is the filtration chamber, which removes additional pollutants by filtering the runoff through a sand bed. The filtered runoff is typically collected and returned to the conveyance system, though it can be partially or fully exfiltrated into the surrounding soil in areas with porous soils.

Sand filters are primarily designed as off-line structures for stormwater quality and typically need to be used in conjunction with another structural BMP to provide water quantity control.

Refer to figures 702.06-1 through 702.06-3 for schematics of sand filters.

Site and Design Considerations

1. The maximum effective drainage area to an individual stormwater filtering system is less than 10 acres. Sand filters cannot be designed to treat the entire contributing drainage area.

2. The design volume must be based on one-inch rainfall and must be designed to fully empty in 36 hours.

3. Adequate pretreatment (e.g., filter strips, see Section 702.06) is required to prevent sediment from overloading the filters. The inlet structure to the filtration chamber must be designed to spread the flow uniformly across the surface of the filter media. Stone riprap or other dissipation devices must be installed to prevent gouging of the sand media and to promote uniform flow.

4. The allowable minimum head is one foot. The maximum allowable head is 6 feet.

5. Construct sand bed to a depth of at least 18 inches.

6. Underdrain pipes must consist of main collector pipes and perforated lateral branch pipes. Reinforce the underdrain piping to withstand the weight of the overburden. Internal diameters of lateral branch pipes must be 4 inches or greater (6 inches preferred) and perforations should be 1/8 inch. Space perforations a maximum of 6 inches between rows. All piping must be schedule 40 polyvinyl chloride or greater strength or similarly rated HDPE pipe. The minimum grade of piping should be 1/8 inch per foot (1% slope). Provide access for cleaning all underdrain piping.

7. Surface filters may have a grass cover to aid in pollution adsorption.

8. Establish vegetation over the contributing drainage areas before runoff can be accepted into the facility.

9. Two allowable surface sand bed filter configurations are:

   Sand Bed with Gravel Layer
   a) Top layer of sand must be a minimum of 18 inches of 0.02 - 0.04 inch diameter sand (smaller sand size is acceptable).
   b) A layer of one-half to 2-inch diameter gravel under the sand must be provided for a minimum of 2 inches of cover over the top of the under-drain lateral pipes.
   c) No gravel is required under the lateral pipes.
   d) A layer of geotextile fabric (permeable filter fabric) must separate the sand and gravel.

Sand Bed with Trench Design

a) Top layer of sand is to be 12-18 inches of 0.02 - 0.04 inch diameter sand (smaller size is acceptable).
b) Laterals to be placed in trenches with a covering of one-half to 2-inch gravel and geotextile fabric.
c) The lateral pipes are to be underlain by a layer of drainage matting.
d) A presettling basin and/or biofiltration swale is recommended to pretreat runoff discharging to the sand filter.
e) A maximum spacing of 10 feet between lateral underdrain pipes is recommended.

Performance Standards

Sand filters designed, constructed and maintained as noted in this manual provide the following pollutant reductions:

Pollutant	Percent Reduction
BOD	60%
TSS	85%
Total P	65%
Total N	50%
Bacteria	40-80%
Metals	60%

Advantages

1. Applicable to small drainage areas
2. Good for highly impervious areas
3. Good retrofit capability

Disadvantages

1. High maintenance
2. Not recommended for areas with high sediment content in stormwater.
3. Relatively costly
4. Possible odor problems

Allowable Sand Filter Variations

There are two primary sand filter system designs, the surface sand filter and the perimeter sand filter.

1. **Surface Sand Filter**- The surface sand filter is a ground-level open-air structure that consists of a pretreatment sediment forebay and a filter bed chamber. This system can treat drainage areas up to 10 acres in size and is typically located off-line. Surface sand filters can be designed as an excavation with an earthen embankment or as a concrete structure. Refer to Figure 702.05-1 for a schematic of a surface sand filter.

2. **Perimeter Sand Filter-** The perimeter sand filter is an enclosed filter system typically constructed just below grade in a vault along the edge of an impervious area such as a parking lot. The system consists of a sedimentation chamber and a sand bed filter. Runoff flows into the structure through a series of inlet grates located along the top of the control. Refer to Figure 702.06-2 for a schematic of a perimeter sand filter.

3. **Underground Sand Filter-** The underground sand filter is intended primarily for extremely space-limited and high-density areas. Refer to Figure 702.06-3 for a schematic of an underground sand filter.

Maintenance

Each BMP must have an operations and maintenance plan submitted to the City for approval and maintained and updated by the BMP owner. Refer to figure 702.06-4 for a checklist for BMP owner routine operation, maintenance and inspection of sand filters. The City will perform annual BMP inspections, using a similar checklist. The owner shall be responsible for maintenance costs and the annual inspection fee. See Section 103.04 for a schedule of fees.

1. A stormwater management easement and maintenance agreement is required for each facility. The maintenance covenant must require the owner of the sand filter to annually clean the structure. A copy of the easement should be included in the digital copy of the BMP operations and maintenance manual.

2. Scrape off sediment layer buildup during dry periods with steel rakes or other devices.

3. Replace some or all of the sand when permeability of the filter media is reduced to unacceptable levels, which shall be specified in the design of the facility. A minimum infiltration rate of 0.5 inches per hour shall be used for all infiltration designs.

Figure 702.06-1 Surface Sand Filter

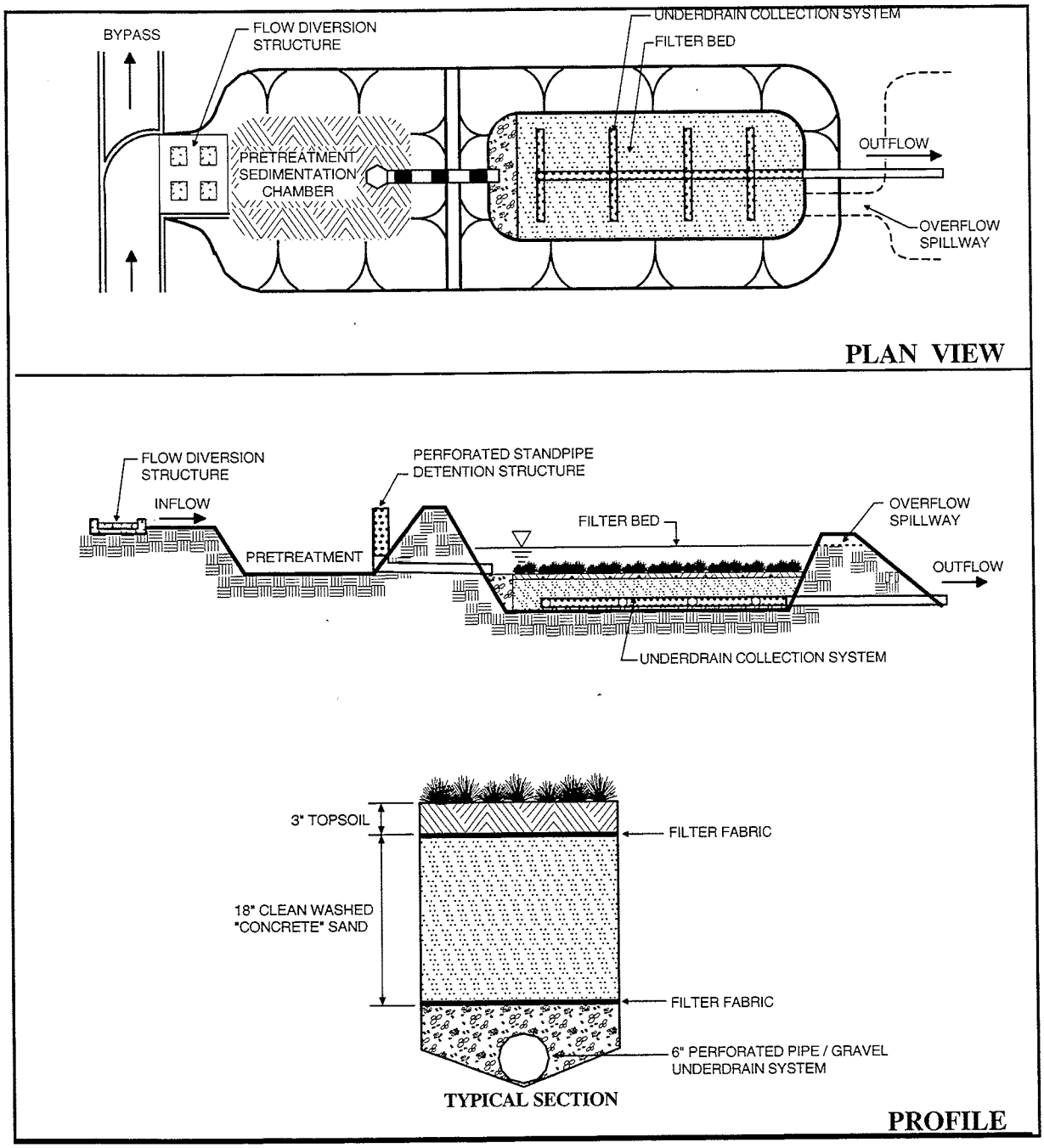


Figure 702.06-2 Perimeter Sand Filter

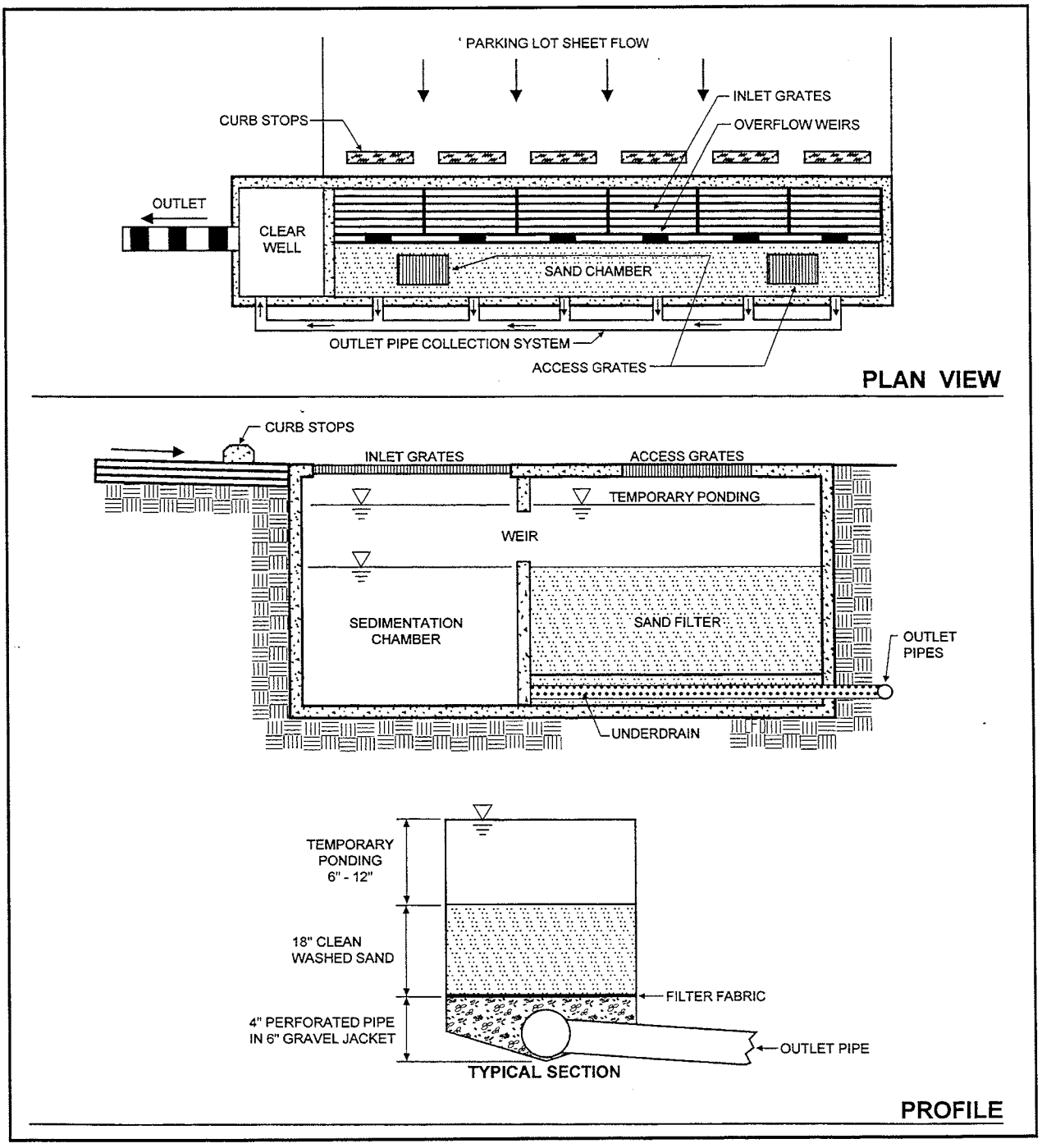
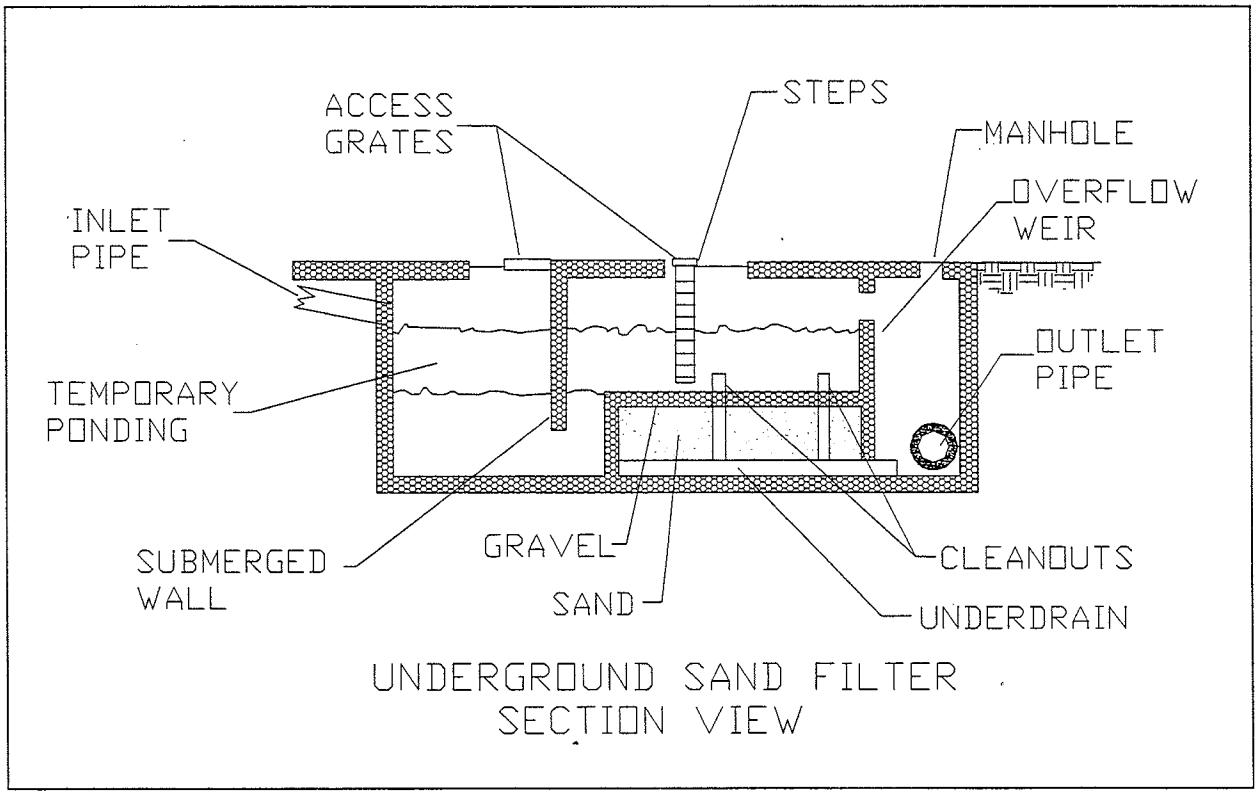


Figure 702.06-3 Underground Sand Filter



Sand Filter Operation, Maintenance, and Management Inspection Checklist for BMP Owners

Site Name: _____ Owner changed since last inspection? Y N

Owner name, address and phone number: _____

Location: _____

Date: _____

Time: _____

Inspector Name: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Debris Cleanout (Inspect monthly)		
1. Filtration facility		
2. Inlet and outlet		
Oil and Grease (Inspect monthly)		
1. Evidence of filter surface clogging		
Vegetation (Inspect monthly)		
1. Surrounding areas stabilized		
2. Evidence of erosion		
Water retention where required (Inspect monthly)		
1. Water holding chambers at normal pool		
2. No evidence of leaking		
Sediment Deposition (Inspect annually)		
1. Filter chamber free of sediments		
2. Sedimentation chamber not more than 50% full		

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Structural Components (Inspect annually)		
1. Structural soundness (deterioration evident)		
2. Grates in good condition		
3. No evidence of structural spalling or cracking		
Outlet/Overflow Spillway (Inspect annually)		
1. Good condition, no need for repairs		
2. No evidence of erosion		
Other (Inspect annually)		
1. No odors		
2. Evidence of flow bypassing the filter		

Additional Comments

Actions to be taken: **Timeframe:**

Dry water quality swales are channels designed and constructed to capture and treat stormwater runoff within dry cells formed by check dams or other means. Dry water quality swales are also described as biofiltration swales. These swales are designed with a limited slope for slow, shallow flow to allow particulates to settle out and to promote infiltration. Water quality swales are limited to areas with low impervious acreage, such as residential and industrial developments.

Dry swales are channels designed with a filter bed and underdrain system. They are designed to filter and infiltrate the entire WQ_v through the bottom of the swale. Runoff is collected by a perforated pipe and discharged at the outlet. Water quality swales are dry most of the time and are therefore well suited for residential areas. Refer to Figure 702.07-1 for a schematic of a dry swale.

Site and Design Considerations

The following site and design criteria must be followed:

1. Water quality swales treat only the WQv. An additional measure is needed to provide detention in conjunction with the water quality swale. The swales can be designed as on-line or off-line structures. Larger storms pass non-erosively through the channels.

2. Water quality swales are limited to peak discharges generally less than 5 to 10 cfs and runoff velocities less than 2.5 ft/sec. The maximum drainage area is 5 acres. The maximum ponding time must be less than 48 hours, and a minimum ponding time of 30 minutes is recommended.

3. The maximum design flow depth is 1 foot, with a ponding depth of 18 inches at the end of the channel.

4. Swale cross-section must have side slopes of 3:1 (h:v) or flatter. Bottom widths must be between 2-8 feet wide.

5. Underlying soils shall have a high permeability (fc > 0.5 inches per hour). Seasonally high water table must be greater than 3 feet below the bottom of the swale.

6. Water quality swales must have a minimum length of 100 feet.

7. Provide a sediment forebay at the inlet to the swales.

8. Locate the swale and all of its components within a drainage easement. The easement should include access to the BMP.

Performance Standards

Water quality swales designed, constructed and maintained (on a 4% or flatter slope) as noted in this manual provide the following pollutant reductions:

Pollutant	Percent Reduction
BOD	10%
TSS	80%
Total P	83%
Total N	92%
Metals	75%

Advantages

1. Typically well accepted in residential settings
2. Inexpensive.
3. Combines water quality treatment with runoff conveyance.
4. Reduces runoff velocities.
5. Low maintenance.

Disadvantages

1. Cannot be used on steep slopes.
2. Can provide a limited amount of stormwater quantity control.

Maintenance

Each BMP must have an operations and maintenance plan submitted to the City for approval and maintained and updated by the BMP owner. Refer to figure 702.07-2 for a checklist for BMP owner routine operation, inspection and maintenance of water quality swales. The City will perform annual inspections. The BMP owner shall be responsible for maintenance costs and the annual inspection fee.

1. A stormwater management easement and maintenance agreement is required for each facility. The maintenance covenant must require the owner of the grassed swale to periodically clean the structure. A copy of the easement should be included in the digital copy of the BMP operations and maintenance manual.

2. Provide adequate access for inspection and maintenance.

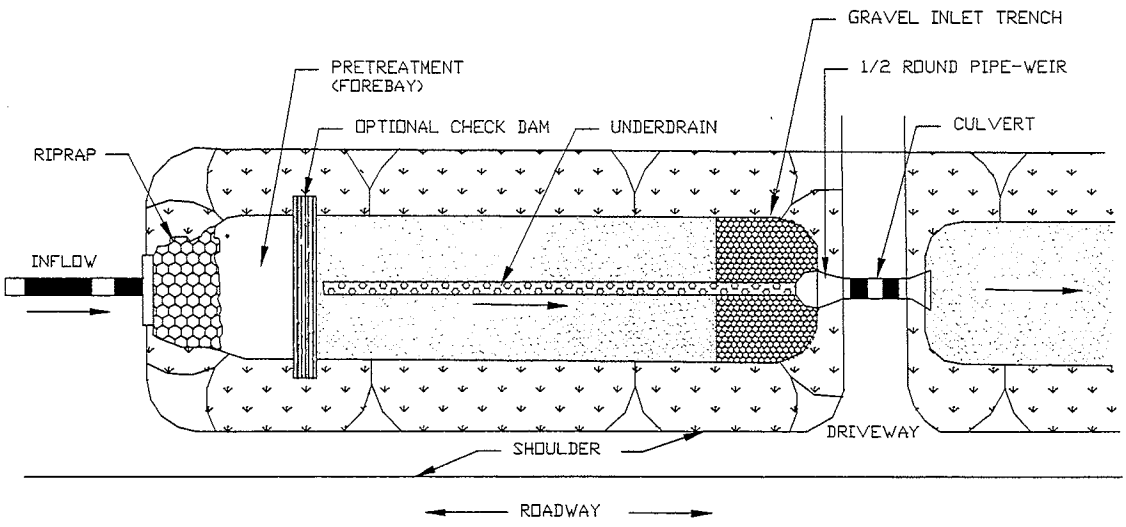
3. Dry swales shall be maintained to keep grass cover dense and vigorous.

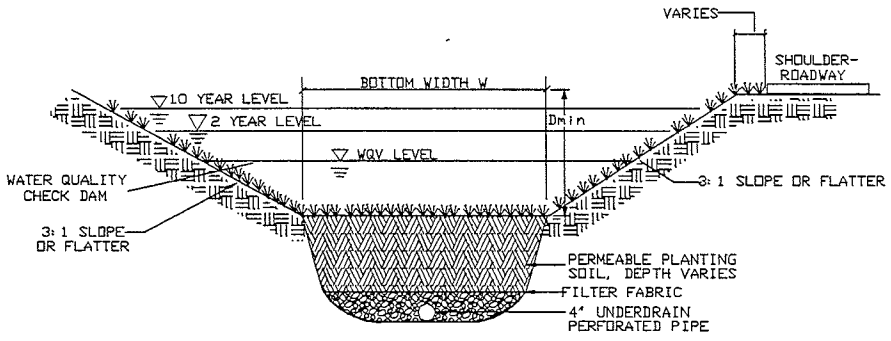
4. At a minimum, maintenance shall include periodic mowing, occasional spot reseeding, and weed control. Swale grasses must never be mowed close to the ground. Grass heights in the 4 to 6 inch range are recommended.

5. Fertilization of grass swale shall be done when needed to maintain the health of the grass, with care not to over-apply the fertilizer.

6. Remove sediment accumulated in forebay when it is 50% full.

Figure 702.07-1 Dry Swale





Water Quality Swale Operation, Maintenance, and Management Inspection Checklist for BMP Owners

Site Name: _____ Owner changed since last inspection? Y N

Owner name, address and phone number: _____

Location: _____

Date: _____

Time: _____

Inspector Name: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Debris Cleanout (Inspect monthly)		
1. Contributing drainage areas free from debris		
Vegetation (Inspect monthly)		
1. Mowing done when needed		
2. No evidence of erosion		
Check Dams or Energy Dissipators (Inspect annually)		
1. No evidence of flow going around structure		
2. No evidence of erosion at the downstream toe		
3. Soil permeability		
Sediment Forebay		
1. Sediment cleanout needed (clean out when 50% full)		

Additional Comments and Actions to be Taken	Timeframe:

Biofilters are densely vegetated sections of land, designed to treat runoff from and remove pollutants through vegetative filtering and infiltration. Biofilters must receive runoff from adjacent areas as sheet flow. The vegetation slows the runoff and filters out sediment and other pollutants. However, the TSS removal provided is less than 80 percent. Therefore, biofilters must be used in a treatment train in conjunction with other management practices to provide the 80 percent performance goal.

Biofilters are best suited to treating runoff from roadways, rooftops, small parking areas and pervious areas. They can be easily incorporated into residential development as land-use buffers and setbacks.

Figure 702.08-1 is a schematic of a filter strip. Figure 702.08-2 is a schematic of a riparian buffer, and figure 702.08-3 is a schematic of a level spreader or flow spreader.

Allowable Biofilter Variations

Filter strip: A filter strip is a uniformly graded and densely vegetated strip of land. The vegetation can be grasses or a combination of grass and woody plants. Pollutant removal efficiencies are based upon a 50-foot wide strip. Refer to Figure 702.08-1 for a schematic of a filter strip. Uniform sheet flow must be maintained through the filter strip to provide pollutant reduction and to avoid erosion.

Riparian buffer: A riparian buffer is a strip of land with natural, woody vegetation along a stream or other watercourse. Besides the undergrowth of grasses and herbaceous vegetation, the riparian buffer includes deep rooted trees. The 20-foot zone closest to the stream or watercourse (Zone 1) contains the trees, while the outer 30 feet of the riparian buffer contains a dense stand of grasses. The overall width of the riparian buffer is 50 feet. Uniform sheet flow must be maintained through the filter strip to provide pollutant reduction and to avoid erosion. Refer to Figure 702.08-02 for a schematic of a riparian buffer.

Site and Drainage Considerations
The following site and drainage considerations must be included in the BMP plan:

1. To ensure sheet flow into the filter strips and riparian buffers, flow spreaders or level spreaders must be designed and installed where concentrated runoff flows into filter strips or riparian buffers.

2. Level Spreader: The grade of a level spreader shall be 0%. The channel grade for the last 20 feet of the dike or diversion entering the level spreader must be less than or equal to 1% and designed to provide a smooth transition into spreader. The depth of a level spreader as measured from the lip must be at least 6 inches. The level spreader lip must be constructed on undisturbed soil (not fill material) to uniform height and zero grade over length of the spreader. The maximum drainage area to the level spreader shall be 10 acres or less with the optimal size being less than 5 acres. The maximum flow into the level spreader must be 30 cfs or less.

3. Appropriate length, width, and depth of level spreaders shall be selected from the following table.

Design Flow (cfs)	Entrance Width (ft)	Depth (ft)	End Width (ft)	Length (ft)
0-10	10	0.5	3	10
10-20	16	0.6	3	20
20-30	24	0.7	3	30

4. Capacity of the spreader, filter strip and riparian buffer length (perpendicular to flow) must be determined by estimating the volume of flow that is diverted to the spreader for water quality control.

5. The released runoff to the outlet must be on undisturbed stabilized areas in sheet flow and not allowed to re-concentrate below the structure.

6. Slope of the filter strip from a level spreader must not exceed 10 percent.

7. All disturbed areas must be vegetated immediately after construction.

8. The minimum filter strip width is 20 feet.

9. Filter strips must be designed for slopes between 2 percent and 6 percent.

10. Ensure that flows in excess of design flow move across and around the filter strip without damaging it.

11. Filter strips can be used effectively as pretreatment measures. The minimum sizing criteria are as follows:

Source: Claytor and Schueler, 1996

Parameters	Impervious Area				Pervious Area (lawns, etc.)			
Maximum inflow approach length (ft)	35		75		75		100	
Filter strip slope (max = 6%)	<2%	>2%	<2%	>2%	<2%	>2%	<2%	>2%
Filter strip minimum length	10	15	20	25	10	12	15	18

12. Riparian buffers: The use of buffers is limited to drainage areas of 10 acres or less with the optimal size being less than 5 acres.

13. Slope of the buffer from a level spreader cannot exceed 10 percent.

14. Top edge of buffer must directly abut the contributing impervious area and follow the same elevation contour line.

15. Biofilters and level spreaders must be located within a drainage easement. A copy of the easement should be included in the digital copy of the BMP operations and maintenance manual.

Performance Standards

Biofilters designed, constructed and maintained as noted in this manual provide the following pollutant reductions:

Pollutant	Percent Reduction (riparian buffer/filter strip)
BOD	40/10%
TSS	60/30%
Total P	35/10%
Total N	25/10%
Metals	70/30%

Advantages

1. Filter strips and riparian buffers can easily be incorporated into new development design.
2. Low maintenance once a dense ground cover is established in filter strips and level spreaders and once trees and other woody vegetation is established in riparian buffers.
3. Riparian buffers provide wildlife habitat.

Disadvantages

1. Filter strips, riparian buffers and level spreaders have limited drainage areas.
2. Constructing a level lip on a level spreader can be difficult. Failure to construct a level lip makes the level spreader ineffective.

Maintenance

A BMP operations and maintenance plan is required for each BMP. The plan must be submitted to the City for approval and maintained and updated by the BMP owner. Refer to figure 702.08-4 for a BMP owner's routine checklist for inspection and maintenance of filter strips and riparian buffers. The City shall perform annual inspections, using a similar checklist. The BMP owner is responsible for maintenance costs and the annual inspection fee.

Figure 702.08-1 Filter Strip

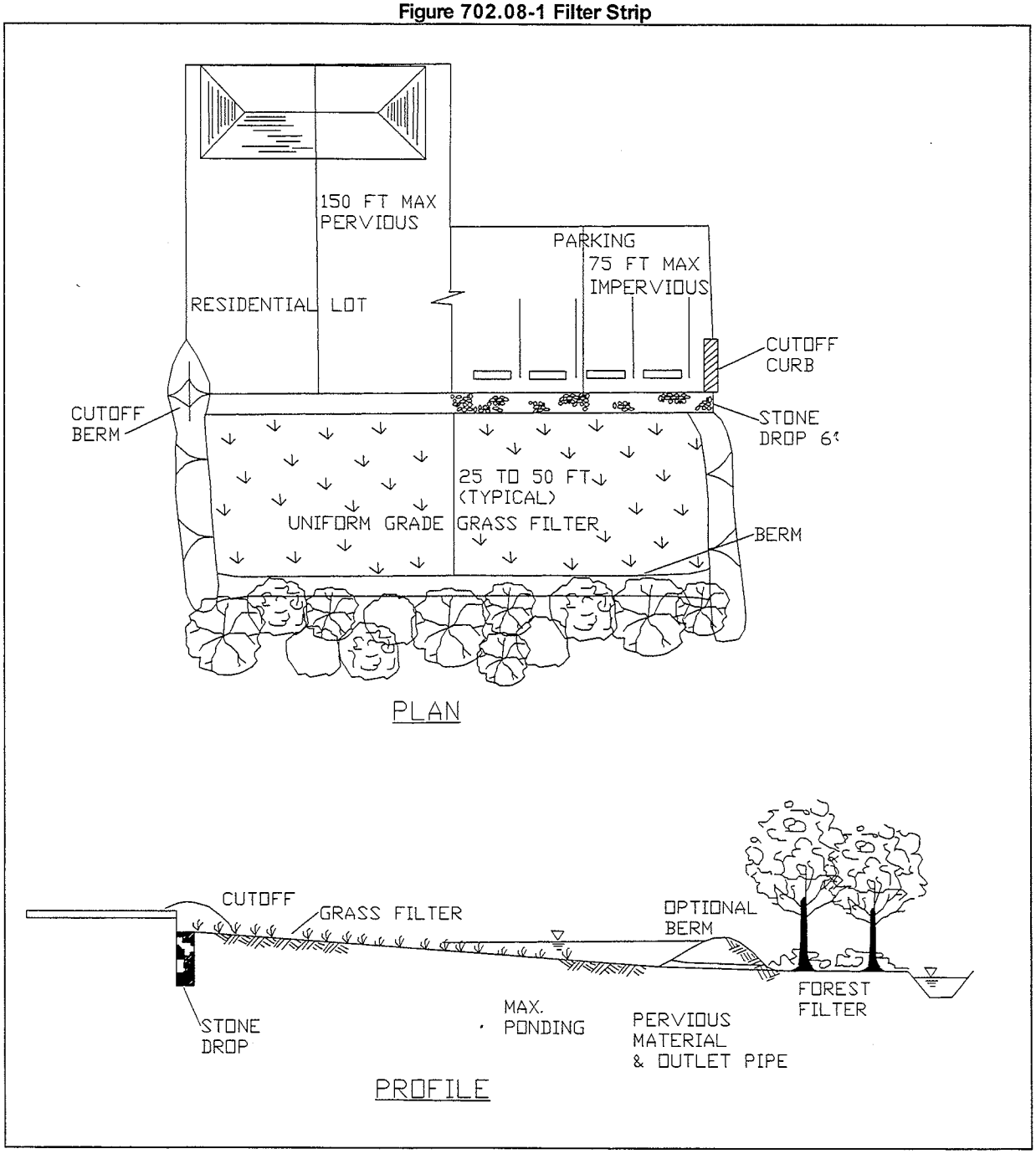


Figure 702.08-2 Buffer
(Source: Controlling Urban Runoff)

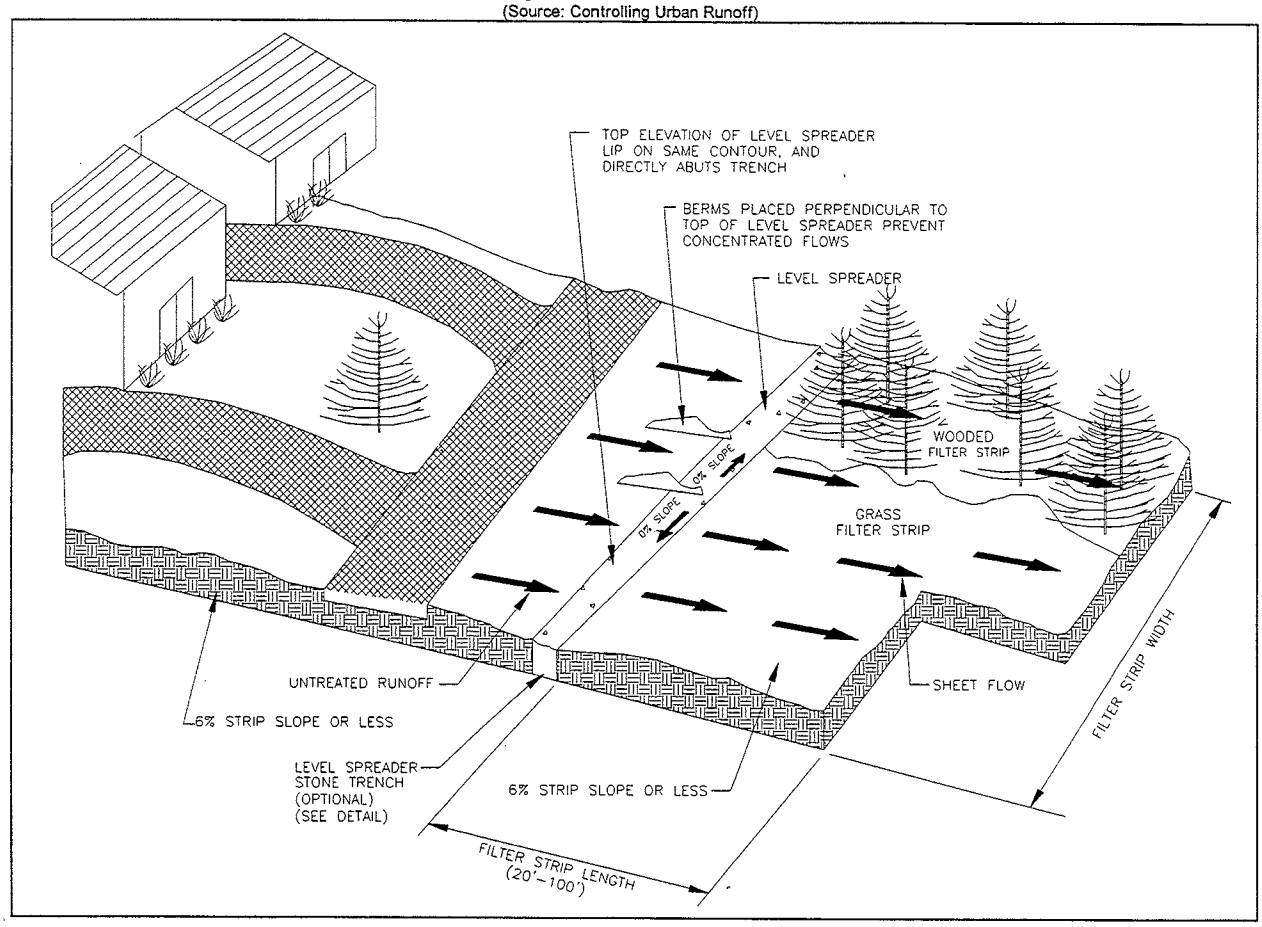
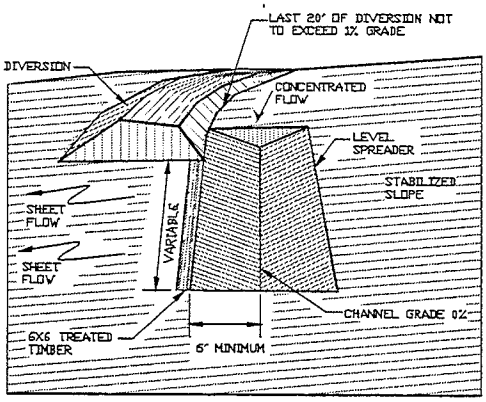
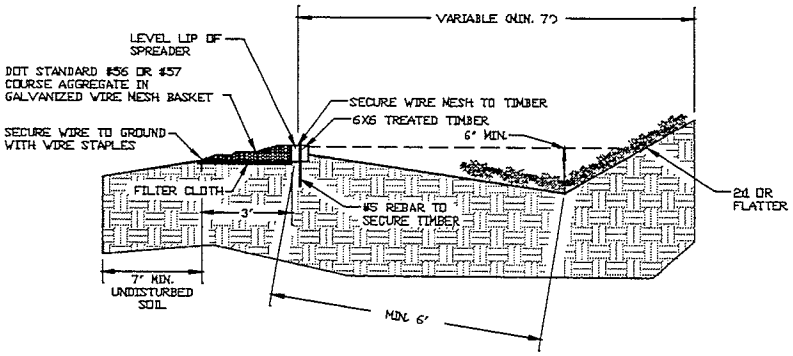


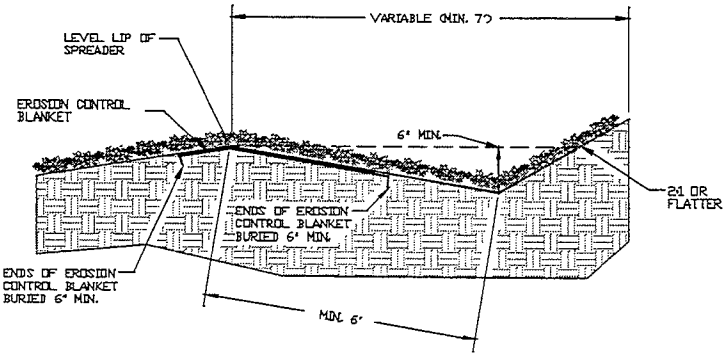
Figure 702.08-3 Level Spreader



PERSPECTIVE VIEW



CROSS SECTION VIEW #1
LEVEL SPREADER WITH RIGID LIP



CROSS SECTION VIEW #2
LEVEL SPREADER WITH VEGETATED LIP

Biofilter and Buffer Operation, Maintenance, and Management Inspection Checklist for BMP Owners

Site Name: _____ Owner changed since last inspection? Y N

Owner name, address and phone number: _____

Location: _____

Date: _____

Time: _____

Inspector Name: _____

Maintenance Item	Satisfactory/ Unsatisfactory	Comments
Vegetation (Inspect monthly)		
1. Plant composition according to approved plan		
2. Vegetation is healthy		
3. Grass height not more than 6 inches		
4. No evidence of erosion		
Level spreader (Inspect monthly)		
1. Vegetation is healthy		
2. Lip of spreader showing no signs of erosion		
3. Sediment noted in spreader?		

Additional Comments and Actions to be Taken:	Timeframe:

702.09
Catch Basin Inserts

Many variations of catch basin insert designs exist. Catch basin inserts can be designed and installed in a storm drain system provided the following minimum criteria for the inserts are met:

1. Provide an overflow weir to pass storm events larger than the design storm.

2. Catch basin inserts must meet the 80% TSS removal rate. Verification of the TSS removal rate must be provided by independent testing, not manufacturer testing.

3. Each design for catch basins can have specific maintenance needs or issues. Maintenance requirements must be clearly defined, and a specific maintenance agreement submitted to the City for review and approval.

Supporting documentation from the manufacturer to verify maintenance requirements and TSS removal rates must be submitted to the City for verification and approval. A maintenance plan must be submitted to the City prior to stormwater management plan approval and maintained and updated by the BMP owner. The BMP owner is responsible for routine maintenance, operation and inspection. The City shall perform annual inspections. The BMP owner is responsible for maintenance costs and the annual inspection fee.

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